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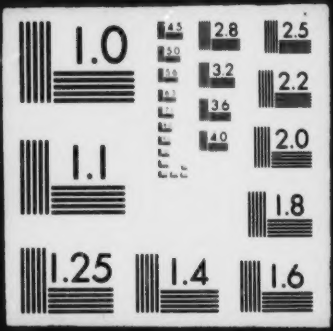
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A STUDY OF FEDERAL SUBSIDIES TO STIMULATE RESOURCE RECOVERY

Resource Planning Associates

Prepared for:

Environmental Protection Agency

1974

DISTRIBUTED BY:

NTIS

National Technical Information Service
U. S. DEPARTMENT OF COMMERCE

BIBLIOGRAPHIC DATA SHEET

1. Report No. EPA/530/SW- 96c

2.

PB 239 736

4. Title and Subtitle
A Study of Federal subsidies to stimulate resource recovery

5. Report Date 1974

6.

7. Author(s)
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8. Performing Organization Rept. No.

9. Performing Organization Name and Address
Resource Planning Associates
44 Brattle Street
Cambridge, Massachusetts 02138

10. Project/Task/Work Unit No.

11. Contract/Grant No.
EPA-68-03-0195

12. Sponsoring Organization Name and Address
U.S. Environmental Protection Agency
Office of Solid Waste Management Programs
Washington, D.C. 20460

13. Type of Report & Period Covered
Final

14.

15. Supplementary Notes

16. Abstracts

This report summarizes a study of Federal subsidies to stimulate resource recovery. It examines subsidies conceptually and in light of past Federal experience; it discusses the characteristics of various subsidies and the manner in which they affect the economics of secondary materials recovery and use; and, it presents estimates of costs and effectiveness of specific subisides for stimulating recycling of specific materials in municipal solid waste. The report describes separately subsidies to stimulate secondary material use and those to stimulate construction of resource recovery plants to remove secondary materials from mixed municipal solid waste. The methodology used in making predictions of subsidy effectiveness is presented as well as a description of the industry economic models to which they were applied.

17. Key Words and Document Analysis. 17a. Descriptors

* Subsidies, * Incentives, * Resource Recovery, * Paper, * Glass, * Steel

17b. Identifiers/Open-Ended Terms

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
US Department of Commerce
Springfield, VA. 22151

17c. COSATI Field/Group

18. Availability Statement

19. Security Class (This Report) UNCLASSIFIED

20. Security Class (This Page) UNCLASSIFIED

21. No. of Pages 144

22. Price 5.75

A STUDY OF FEDERAL SUBSIDIES
TO STIMULATE RESOURCE
RECOVERY

This final report (SW-96c) describes work performed for the Federal solid waste management programs under contract No. 68-03-0195 to RESOURCE PLANNING ASSOCIATES, INC. *and is reproduced as received from the contractor*

U.S. ENVIRONMENTAL PROTECTION AGENCY

1974

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An environmental protection publication (SW-06c) in the solid waste management series.

FOREWORD

The need for expanded markets for secondary materials, particularly those found in municipal solid waste, has resulted in suggestions from the private sector, from state and local governments, and from the Congress that consideration be given to providing Federal subsidies to stimulate these markets. Similarly, the possible need for subsidies to stimulate the construction of plants to process mixed municipal refuse and recover materials and energy from it has been widely speculated. The numerous environmental and conservation benefits that such increased recycling could produce suggest that Federal subsidies deserve careful analysis.

This report examines potential Federal subsidies from several key standpoints. It looks at subsidies conceptually and in the light of past Federal experience, it discusses the manner in which different subsidies operate to achieve their purpose, and it makes specific estimates of the cost and effectiveness of several measures for stimulating markets for selected recycled materials and for accelerating the rate of construction of municipal recovery plants.

The complexity of these issues can hardly be overstated, particularly the making of specific estimates of subsidy effectiveness. Not only is complete industry economic data not generally available, but in addition conditions change with changes in the overall economy and other factors. Therefore, all specific estimates are necessarily subject to these very significant constraints.

Nevertheless, the information in this report should add to our understanding of the issue of Federal subsidies for stimulating resource recovery. We consider this report to be a useful source of data in this regard, though certainly not the only data which must be considered in making decisions in this very complicated area. The report is by no means a statement of EPA policy on resource recovery subsidies.

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INTRODUCTION

This report presents the results of a study to predict the increase in recycling that would result from the application of Federal subsidies to major users and suppliers of post consumer waste (PCW).* A companion Appendix Volume report presents the details of the calculations and the backup for the results presented here.

The effort was divided into two major activities:

- study of existing and previous Federal subsidy programs to develop guidelines and criteria for evaluating proposed resource recovery subsidies.
- development and application of a methodology for evaluating the impacts of a variety of economic subsidies to users and suppliers of PCW.

The focus of the program was on evaluating subsidies that provide a direct economic benefit to users and suppliers of PCW. The program also focused on the three major components of PCW: paper, ferrous metals (predominantly cans), and glass (predominantly bottles).

Section I of this report presents a discussion of subsidies in general and describes the operation of those studied in this program. Section II describes the study methodology and presents the results of the application of subsidies to users and suppliers of PCW. The Appendices present background on the users and processing systems and an example of the application of the methodology to a specific case.

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* The General Services Administration of the Federal Government defines post-consumer waste as "materials which have passed through their intended use and been collected from homes, offices, factories, or municipal solid waste. Industrial waste would principally include waste generated in the manufacturing process (cuttings, trimmings, converting waste, etc.), forest residues and related waste obtained after manufacturing, harvesting, converting and similar industrial processes. Under this term, paper mill broke--that material generated in the paper-making process up to and including the cutting and trimming of the paper machine reel into smaller rolls or rough sheets--is eliminated from qualifying toward recycled content.

SECTION I

SUBSIDY DESIGN CONSIDERATIONS

Introduction

A subsidy is defined by the Joint Economic Committee of the Congress of the United States as "the provision of Federal economic assistance to a producer or consumer of a particular good, service or factor of production for which the Government receives no equivalent compensation in return but conditions the assistance on a particular performance by the recipient that alters the price or cost, so as to encourage or discourage the output, supply, or use of these items and the related economic results."[1] The assistance can take many forms including: direct cash payment, reduction of taxes, low interest loans, provision of goods or services at below market value, purchases of goods and services above market price and regulatory actions that alter particular market prices.

Subsidies are used to correct market defects that cause too much output of some goods or not enough output of other goods. These market shortcomings, resulting in an inefficient allocation of resources, are caused by one or more of the following major factors:

- Lack of Mobility - Investment in production process tends to be fixed in the short term limiting the ability to invest in new processes even after it becomes clear that the nature of a market is changing.

- Imperfect Information - One of the more important effects of a lack of knowledge or information is the inability to assess the risk of certain ventures. For example, the uncertainties of the quality, volume and price of waste paper has, to some extent, inhibited new investment in secondary fiber based capacity.

- Cost Conditions - Conditions in segments of some industries preclude any one firm from expanding the segment by itself. A subsidy might allow all firms to expand, lowering prices but also lowering costs. The combination board segment of the paperboard industry might be an example of this "chicken and the egg" problem.

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[1] "The Economics of Federal Subsidy Programs", A Staff Study Prepared for the Joint Economic Committee, Congress of the United States (U.S. Gov't. Printing Office, Washington, January 11, 1972).

- Externalities - There are cases where all costs and benefits are not accounted for in the market. A good example would be the environmental benefits and energy savings that would result from an increase in recycling vis-a-vis disposal and consumption of virgin resources.
- Factor Employment - Under-utilization or over-utilization of raw materials can cause side effects outside the economic system. A subsidy might stimulate a "better" mix of raw materials, for example, a higher proportion of secondary materials, thereby conserving energy and virgin materials.
- Price Instability - An unstable market can have a negative effect on growth. Subsidies may be effective in stabilizing widely fluctuating secondary material prices.

Each of these factors has been used to justify subsidies in the past. Each of these factors could be used to justify subsidies for increasing resource recovery.

The Issue of Subsidy Design and Evaluation

Background

Recent studies within the United States Congress and the Administration have found that Federal subsidies constitute a widely diversified and pervasive system of economic assistance. Lack of information on the various forms of subsidies, coupled with a lack of comprehensive reporting have generally masked the real costs of the myriad of subsidy programs. Very little is understood about the economic effects of subsidies: who really benefits, versus who receives the subsidy; to what extent the economy is distorted, wasting resources, aggravating inflation or causing inequitable income distributions.

However, no tried and tested framework exists to enable the policymaker to choose among available subsidies. In many cases in the past the decision was based on the current political pressures and a feeling that a subsidy would seem to provide required aid. This simplistic approach to such a complex issue has, in a number of instances, led to failure to accomplish the desired objective and inefficient use of public resources.

Common Causes of Subsidy Ineffectiveness

An analysis of Federal subsidies indicates at least four underlying causes for their general lack of effectiveness or inefficiency.[1]

. Failure to identify and deal with the real market defect. The functioning of the market system is enormously complicated in practice and the task of differentiating between cause and effect is at times impossible. Yet an incorrect definition of the problem can lead to the selection of an inappropriate subsidy or point in the supply-demand cycle for its application. A common mistake in this regard is that subsidies tend to be used in situations involving inelasticity of supply or demand. That is, a percentage increase (decrease) in price results in less than a corresponding increase (decrease) in output. This inelasticity can be caused by a wide range of factors and if the subsidy program does not correct the cause of the inelasticity, the inelastic factor, rather than the direct recipient of the subsidy, will determine who benefits. For example, if the problem is an inelastic supply of a raw material caused by a lack of information among suppliers, a subsidy that raises the effective price may not be as effective as a federally sponsored training or assistance program.

. Failure to motivate actors directly to make best use of the subsidy. The existence of a subsidy program does not insure its use. Institutional and knowledge constraints often require the active participation of the concerned agency in the provision of services to individual subsidy recipients, such as: planning and allocative assistance, marketing studies, and general business assistance.

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[1] "Economics of Federal Subsidy Programs", Joint Economic Committee of the U.S. Congress (U.S. Government Printing Office, Washington, D.C., January 11, 1972).

. Failure to differentiate between windfalls and incremental benefits occurring because of the subsidy. For the most part, subsidies reward incremental actions resulting from the subsidy on an equal basis with those actions which would have been carried out whether or not the subsidy existed.

. Lack of organization, control and review. No one federal agency is responsible for monitoring the operation of all subsidy programs. As a result there is no centralized mechanism for evaluating the compatibility and effectiveness of the large number of widely diversified programs. A case in point is the apparent inconsistency of depletion allowances with a recycling subsidy.

Design

The most important requirement in designing a subsidy is that the problem be thoroughly understood. This understanding should extend beyond acknowledgement of the symptoms, to the underlying cause. Only then can it be decided whether or not the subsidy will be effective. Without this analysis the subsidy is in danger of becoming little more than a transfer payment, resulting in substantial windfalls. For example, providing a subsidy for use of a waste material when technological rather than economic problems inhibit its extraction from the waste stream or its use by manufacturers, will do little at least in the short run to increase recycling and will simply result in a windfall. This is closely related to the issue of identifying inelastic factors.

In designing a subsidy, consideration should be given to how the subsidy program would end. At what point do the marginal costs exceed marginal benefits? At what level of activity can it be said that the subsidy has attained its goals and is no longer useful? Finally, what is the tradeoff between permanency of the subsidy (encouraging decision-maker confidence) and the ability to adjust or terminate the subsidy as market conditions change. This is an important factor in comparing different subsidy types and will be discussed later.

Evaluation

The evaluation criteria presented in this section indicate the kind of complete analysis which should be carried out prior to initiation of any subsidy. Many of these criteria involve qualitative judgements which ultimately must be made by the government decision-maker. The analysis described in this report concentrated on evaluating subsidy effectiveness and cost to the government, the major elements of the benefit/cost criteria.

Benefit/Cost Analysis

The principal measure of a subsidy's benefit is output. This output can be defined as the increase in the level of a given activity which contributes to the subsidy's goals. It is important to note that the increase in activity alone may not be a benefit unless it moves toward the goals. For example, a job training program for the unemployed is ineffective unless net employment increases as a result of the subsidy.

The costs of a subsidy, of course, are measured principally in dollars.

Proper benefit/cost analysis also must include a consideration of intangibles. For example, increased public awareness of an issue may be considered an intangible benefit. Similarly, temporary economic disruption may be considered an intangible cost.

Achievement of Legislative Intent

It is important to provide for detailed checking procedures and restrictions which would insure that the subsidy recipients are complying with the intent of subsidy legislation. For example, a subsidy to increase recycling by encouraging purchase of equipment which uses waste products as a raw material would be subverted if the recipient used virgin materials.

Net Income Transfer

In examining the net income transfer, all sources and recipients of the subsidy should be reviewed. For resource recovery subsidies, it may be deemed appropriate that citizens, as producers of waste, pay for the subsidy through tax dollars, while recyclers, as agents that help to alleviate the solid waste burden, receive the subsidy. Examining only the direct recipient of the subsidy, however, is not enough. One must also estimate whom the subsidy dollars will ultimately benefit after resulting price increases or decreases. Here again the importance of the inelasticity in supply or demand is shown, since this factor would dictate to a large degree the ultimate recipient of the subsidy and the final net income transfer. For example, if waste supply were inelastic, a subsidy given to users to encourage demand would largely end up in the hands of suppliers as the result of price increases.

Practical Problems

There are a number of practical problems which must be addressed. These include how well the effects can be predicted, the extent to which potential recipients can understand the subsidy, and the lead time necessary to implement the subsidy and see results. Predicting effects can be particularly troublesome since predicting any market changes is often very difficult. Many well-intentioned subsidy programs have produced results other than those envisioned by the initiators.

Legislative and Political Problems

There are political problems which must be addressed in evaluating the potential subsidy. It is impossible to list all of the potential issues. Certainly one problem is which agency is appropriate to be responsible for review and control. This is particularly important in comparing tax with cash subsidies, the former administered by the Treasury Department and the latter by some other Federal agency. The nature of the legislative review procedure both before and after subsidy initiation may also significantly influence the choice of tax vs. cash subsidies. The overall fiscal policy of a given administration is highly important in swinging the balance for or against a given subsidy measure.

Review

It is essential that any subsidy program undergo a periodic review. Ideally this review should be conducted by the Congressional Committee or Agency most knowledgeable in the problems the subsidy is designed to correct. This review procedure has not been conscientiously carried out for many of the subsidy programs now existing, particularly those in the form of tax credits, for which annual budgeting is not required. The review process must contain at least the following five considerations:

Goals

What was the original intent of the subsidy? Is this still a realistic goal? Has the subsidy been instrumental in moving toward the goal?

Benefits

What has been the output stimulated by the subsidy? Have windfalls been substantial? What has been the distribution of benefits? Are there any ancillary benefits worthy of consideration?

Costs

What has been the cost of the subsidy? Have all costs been included, including foregone or delayed tax revenues? Have the social costs of economic disruption been considered? Has the subsidy conflicted with other goals?

Compliance

Have there been incidences of recipients avoiding the subsidy's intent but still reaping benefits? Is compliance being slowed by complexity or lack of knowledge possessed by potential recipients?

Change Mechanisms

Can the subsidy be redesigned to make it more effective in light of the previous year's experience?

Though not an exhaustive discourse on subsidy design, evaluation, and review, the considerations presented above include the basic factors critical to prudent use of subsidies.

Subsidy Options

There are a number of different mechanisms by which subsidies can be delivered. They can most easily be classified by type and form.

Subsidies may be either capital or operating in type. Capital subsidies tend to be tied to plant, equipment, or ownership capital. In most cases, these appear to involve a fixed payment to the recipient. Operating subsidies, on the other hand, tend to be process-oriented and tied to input or output. Their levels tend to fluctuate with details of the production process.

The forms of subsidies include direct cash payment, reductions of taxes, low interest loans, benefit-in-kind, i.e., provision of goods or services at below market value or purchase of goods or services above market price, or provision of research or information, and regulatory actions that alter particular market prices. Exhibit I-1 gives examples of how the various types and forms of subsidies may be applied. Analysis in the study was directed at only cash, tax, and credit subsidies since these are the most direct forms of purely fiscal incentives. It was felt that these forms in general were the most applicable to resource recovery. However, purchase subsidies involving price supports, stockpiling or similar measures may well deserve further consideration. Benefit-in-kind subsidies are in essence being carried out now through provision of Federal technical assistance, i.e., provision of information.

Characteristics of Capital and Operating Subsidies

Capital Subsidies

Theoretically, capital subsidies should be used where capital poverty is a perceived problem. However, in the past, they have been used primarily where it was believed that equipment cost was a barrier to a desired activity. As would be expected, capital subsidies are more effective where capital intensiveness is involved. For example, in the case of resource recovery, capital subsidies would not be appropriate for encouraging demand for waste glass (cullet) since only minor equipment costs are incurred in altering equipment to manufacture glass from cullet rather than virgin raw materials.

Because of their effect on capital intensive systems, capital subsidies can result in overcapitalized technology, inadequate maintenance, and premature replacement. The reason for this phenomenon is that, in the past, recipients have not internalized the cost paid by the Federal government. For example, in Cleveland and Chicago, it was discovered that subsidizing part of the transportation system reduced bus lifetime by one half because total costs were not perceived, and the cost of replacement assets was reduced for the cities.

From the recipients's point of view, there is little concern with subsidy continuance with capital subsidies. Because commitments are usually of a fixed nature for a fixed period of time (with the amount paid or guaranteed at the time of commitment) discontinuation of the subsidy to new recipients does not cause problems for those who have made decisions based on its continuance.

Where capital subsidies are granted there is a need to insure that the goals of a program are attained. All subsidies involve a quid pro quo, that is, in return for a subsidy, a desired action is taken. Capital subsidies tend to make the commitment in advance of the action. For this reason, it is essential that the recipients are not forgotten, but that they are reviewed to determine compliance, and that some recapture provision be included for non-compliance.

Operating Subsidies

Operating subsidies are aimed at one or more of the operating parameters (revenues, raw material costs, labor costs, utility cost, etc.) and can take any of the forms mentioned above. The subsidy then varies continually, based on the level of these input or output parameters. The granting of an operating subsidy must be seen as long-run in nature in order to be effective in motivating economic actors. Yet, the granting or appearance of a long-run subsidy leads to an inability to end the subsidy without substantial economic disruption. For example, if an operating subsidy were granted for the use of waste paper, then it is likely that waste paper using paper mills would be built on the basis of the improved economics of waste paper use. Discontinuation of the subsidy before the mill's useful lifetime has ended would result in substantial economic damage to the mill owner, who has acted in good faith. Thus these subsidies develop a strong constituency for continuance; to avoid conflicts, time frames for continuance can be established in advance.

It is important to realize that in the case of a subsidy's applicability to resource recovery, the purpose and desired result of both capital and operating subsidies is stimulation of capital investment in facilities that use secondary rather than virgin materials.

Characteristics of Forms of Subsidies

As stated previously, this discussion will concentrate on cash, tax, and credit forms of subsidies only.[1]

Cash Subsidies

A cash subsidy, whether based on capital equipment or operating parameters, is a direct cash disbursement to the recipient. From the recipient's point of view, cash subsidies are straightforward and understandable. They may be used regardless of tax status or credit position.

The fact that this form of subsidy is a cash disbursement makes it appropriate to be included in the Federal budget as a separate item at its full cost. This characteristic means that the subsidy will undergo a thorough review process by a Congressional Committee or Administrative Agency. However, it also makes the subsidy seem less permanent to the recipient.

Typically, the Committee or Agency responsible for the review has an accumulated expertise in the problems which resulted in the subsidy's proposal. This implies that it will receive a more effective review.

In the past, cash subsidies have tended to provide for the most appropriate level of administration. The administrative procedures have tended to be complicated to insure compliance with the subsidy. This is due to the detailed checking procedures involved in awarding subsidies and verifying performance. However, this aspect of cash subsidies should not be considered detrimental, since other types of subsidies have suffered from a lack of administrative control.

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[1] A more lengthy and detailed discussion of characteristics of different subsidy forms may be found in: Economics of Federal Subsidy Programs, Joint Economic Committee of Congress (U.S. Government Printing Office, Washington, D.C., January 11, 1972).

Tax Subsidies

Recent controversy over the equitability of tax subsidies, and proposals to reform so-called tax loopholes may change the characteristics of tax subsidies significantly. The following discussion of characteristics, based on an analysis of past tax subsidies, does not reflect possible changes on tax subsidy mechanisms that may occur.

Tax subsidies have, in the past, been easier to get through Congress than equivalent cash subsidies. The reason is that a tax subsidy does not usually involve an expensive administering bureaucracy and does not require budget allocations. This factor is itself a cause of inefficiency and ineffectiveness in tax subsidies. The lack of an administering agency means a lack of control over the variables that insure the subsidy's effectiveness. However, to the recipient it indicates permanence and assurance that the subsidy will continue, which leads to greater willingness to include the subsidy as part of normal planning procedures.

Tax subsidies are examined by the House Ways and Means and the Senate Finance Committees rather than by the committee concerned with the subject at hand. This makes it difficult for Congress properly to manage national priorities.

Further, IRS agents enforce the subsidy. Because they are usually not as informed about the purposes behind the legislation as the initiating agency, they may not audit as appropriately as would members of the concerned agency. The administrative problem is further compounded by the fact that the proper "cost" of a tax subsidy is Federal revenue foregone, an item difficult to locate in the budgetary process. This cost may not receive the same type of scrutiny given to other items, such as cash or credit subsidies.

Theoretically, the effectiveness of a tax subsidy could be diminished by corporate organizational structures.

Tax subsidies may be less of an incentive to the middle management decision maker. As Holland points out, as one moves down the hierarchy from corporate treasurer, the more direct the subsidy, the more understandable and predictable its effect.[1] At the top management level, tax or cash may be of equal understandability. If the decision-maker is, for instance, at the plant level in a decentralized organization stressing cost center accounting, a tax credit could be significantly less effective. A tax credit is reflected at the firm level, and a middle manager undertaking a direct differential loss for use of a subsidized product will be much less inclined to fulfill the intent of the subsidy than he would be were it a cash subsidy, because he may not receive credit for it in his superiors' evaluation.

On the other hand, firms have had a good deal of experience with tax credits and this problem may be more theoretical than real. Also, most firms feel that their receipt of a subsidy is less obvious if it involves a tax credit rather than a cash payment.

Credit Subsidies

Credit subsidies may take the form of direct government loans at a favorable rate, government guarantees of interest and/or principal, government insurance of a borrower, loans to creditors who could not otherwise borrow, or direct payment of a percentage of the creditors' interest.

The amount of review that a credit subsidy receives is dependent on its form. For example, if the Federal Government paid a percentage of a creditor's interest payment, these payments would appear in full in the Federal budget. On the other hand, government guarantees of loans may not include a specific dollar amount.

From the recipient's point of view, credit subsidies, which are usually capital subsidies, tend to be easy to evaluate. The terms, conditions, and time frame of the credit subsidy are usually specified in advance, easing fears of subsidy termination.

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[1] Daniel Holland. "An Evaluation of Tax Incentive for oh the Job Training of the Disadvantaged," The Bell Journal of Economics and Management Science, Volume II, No. 1.

From the administrative agencies' viewpoint, credit subsidies are attractive in that there is usually a less strong constituency advocating a credit subsidy's continuance. That is, as long as obligations to previous subsidy recipients are fulfilled, the subsidy program may be terminated by granting no new credit subsidies and allowing previous obligations to run their course.

SECTION II

PREDICTION OF SUBSIDY IMPACT

Subsidies Examined

This section represents the second phase of "A Study of Federal Subsidies to Stimulate Resource Recovery." Phase I, summarized in the previous section, was a generic analysis of types and forms of subsidies.

The second phase is concerned with determining the increase in recycling induced by a Federal subsidy, assuming that it is properly designed, implemented, and administered. Our analysis focuses on two specific subsidy recipients: industrial users of post consumer waste and municipally-owned resource recovery plants. Exhibit II-1 summarizes the specific subsidies examined and their recipients.

This section of the report summarizes the methodology and logic that were used in developing predictions of subsidy effectiveness and then presents the results of the analysis. It was assumed that only post consumer waste or equipment using post consumer waste would be eligible for subsidies. Mill revert scrap and conversion or fabrication scrap were excluded since economics already favor recycling of this scrap.

Subsidies to Industrial Users of Post Consumer Waste

Outline of Prediction Methodology

A subsidy to users of post consumer waste is intended to make post consumer waste a more economically attractive raw material compared with virgin raw materials.

The purpose of the methodology is to provide a means of evaluating the economic impact of a variety of subsidies and of predicting their effect on the level of usage of PCW in the paper, steel, and glass industries.

A number of prediction techniques were considered: surveys, the Delphi method, and computer simulations based on economic models describing an industry. The methodology employed is a composite of these techniques. Essentially, it is an attempt to predict investment decisions based on changes in return on investment.

EXHIBIT II-1

SUBSIDY RECIPIENTS/SUBSIDY TYPES

Municipally Owned Resource Recovery Systems (Processors)
(See Appendix D)

- Mechanical Processing into saleable raw materials (Black-Clawson model)
- Incineration with Residue Recovery (Bureau of Mines model)
- Fuel recovery for Utility Boilers (St. Louis model)
- Incineration with Waste Heat Recovery
- Direct conversion of combustion gases into electricity (CPU-400-Model)
- Pyrolysis

⇧

PCW PROCESSOR SUBSIDIES

- Operating
  - 30% of Selling Price
  - $6 per ton sold
- Capital
  - 25%, 50%, 75% construction grants
  - 75% Credit

Users of Post Consumer Wastes (Users)
(See Appendix A)

- Waste Paper Users
  - Linerboard mills
  - Corrugating medium mills
  - Folding boxboard mills
  - Newsprint mills
  - Tissue mills
- PCW Can Users
  - Mini-mills
  - Detinners
- PCW Bottle Users
  - Bottle Making Plants

⇧

PCW USER SUBSIDIES

- Operating
  - 30% of purchase price
  - $6 per ton purchased
- Capital
  - 25% investment tax credit
  - 5-year accelerated depreciation
  - 75% credit

Data on the separate supply and demand functions of waste materials is not available and would be difficult to obtain. Thus, a methodology of applying price and cost changes to supply and demand curves could not be developed.

Two types of macro-economic information were gathered in order to predict the increased level of recycling that would result from subsidy-induced changes. These are:

1) The actual economic impact of a subsidy on a given industry or industry segment (i.e., the extent to which the subsidy alters profits or return on investment).

2) The maximum recycling possible, based on uses of waste materials, total capacity, plant and equipment obsolescence, market growth, technological constraints and other factors.

These data were used in conjunction with a decision model which predicted investment based on changes in return on investment. This procedure included:

1) Development of preference curves for each industry segment, relating investment to changes in return on investment.

2) Development of risk and learning curves to modify the basic investment curves.

3) Calculation of an equilibrium increased recycling estimate.

The above stages will be discussed followed by a description of the results of the predictions.

Impact of Subsidies on Plant Profitability

Description and Illustration of Subsidies Examined

Before presenting the results of the profitability analysis we shall examine the impact of a subsidy on the internal rate of return of a hypothetical user, and illustrate the calculations necessary to show the impacts. The income statement of a hypothetical user is presented in Exhibit II-2. As the income statement shows, our hypothetical user consumes both virgin materials and post-consumer waste as raw materials.

Two factors need particular explanation in this example and for all of the income statements shown in this section: interest expense and cashflow. Most companies in the United States do not finance their capital needs

EXHIBIT II-2

HYPOTHETICAL USER

INVESTMENT REQUIRED	$200, 20 year life
REVENUE	$400
COST OF GOODS SOLD	
Virgin raw materials	$150
Post-consumer waste	$150 (10 Tons)
GROSS MARGIN	$100
SELLING, GENERAL, AND ADMINISTRATION	
Depreciation	$10
Other	50
Interest*	18
Profit before tax	22
Tax	11
Profit after tax	11
Cashflow	21

*9% interest for 100% financing of investment by using 100% debt and no equity capital. In fact, the proportion of debt to total capital varies widely among industries and among companies within the same industry. To insure comparability, the assumption is made that 100% of the new investment for plant and equipment is financed with debt at 9% interest rate.

The nature of cashflow must also be examined. Cashflow is the amount of cash that a specific project generates during some period of time, and represents both a return to capital (profits) and a return of capital (depreciation). For an income statement, cashflow can be calculated by adding profit after tax plus all non-cash expenses (primarily depreciation).

Exhibit II-3 shows how each of the five subsidies to user industries would affect the income statement of the hypothetical user. These subsidies were selected because they encompass the range of practical alternatives. Specific observations on each subsidy are presented below.

Purchase Price Subsidy Equal to 30% of Input Cost. A "percent of purchase price" subsidy to users of post consumer waste consists of a taxable cash payment from the Federal Government to the user company, based on the total market price paid for post-consumer waste. The specific subsidy considered was a 30% of purchase price cash subsidy.

Note that increases in both the profit after tax and cashflow are less than the full amount of the subsidy because some of the subsidy is returned to the government in the form of taxes. The impact of the subsidy is greater where a company uses a high percentage of post consumer waste in the production process and where the waste material used has a high value.

In order to stimulate industries to add PCW-based capacity, the subsidy must continue for a period roughly comparable to equipment life. The calculations in Exhibit II-3 assume that the subsidy is paid over the entire life of plant and equipment. If the subsidy continues over a long period of time, industries may come to view the profitability of PCW based production as relying solely on the subsidy. This would tend to create a large and vocal constituency whenever the continuance of the

EXHIBIT II-3

APPLICATION OF SUBSIDIES TO HYPOTHETICAL USER

	No Subsidy	30% of Purchase Price Subsidy	$6/ton of Input Subsidy	75% Credit Subsidy	25% Invest-Credit		5 Year Accelerated Depreciation	
					Yr. 1	Yr. 2-20	Yr. 1-5	Yr. 6-20
REVENUE								
Sales	400	400	400	400	400	400	400	400
RAW MATERIAL INPUT								
Virgin	150	150	150	150	150	150	150	150
10 tons PCW @ $15	150	105	90	150	150	150	150	150
SELLING, GENERAL, & Administrative								
Depreciation	10	14	10	10	10	10	25	5
Other	50	50	50	50	50	50	50	50
Interest	18	18	18	11.25	18	18	18	18
PROFIT BEFORE TAX	22	67	82	28.75	22	22	7.5	27
TAX	11	33.5	41	14.38	-14	11	3.75	13.5
PROFIT AFTER TAX	11	33.5	41	14.37	36	11	3.75	13.5
CASHFLOW	21	43.5	51	24.57	46	21	28.75	18.5

subsidy was threatened.

The dollar outlays for the subsidy are difficult to predict because the payments increase with both the absolute amount of tons recycled and the market price. The fact that the dollar value of the subsidy increases as PCW market price increases has both positive and negative implications. From the recipient's standpoint it is positive, in that the subsidy reduces the risk associated with waste material price increases. As the price of PCW raw material goes up, as often happens in scrap markets, part of the impact of that rise is borne by the Federal Government. In fact, the price of PCW input could rise by as much as 42% before the user is in the same profit and cashflow position as he would be without the subsidy. The negative implications are that: 1) the subsidy may encourage price increases, 2) higher valued (inherently more recyclable) scrap is subsidized more than lower valued (inherently less recyclable) scrap, and 3) the cost of the subsidy is difficult to predict.

The major administrative problem is the need to establish a comprehensive system to differentiate, at the mill level, post consumer waste from prompt scrap or mill broke.

$6 Per Ton Subsidy. A per-ton subsidy is a taxable payment from the Federal Government to the user of post consumer waste. The subsidy selected for analysis was $6 per ton.

The effects of a $6 per PCW ton subsidy on our hypothetical user are illustrated in Exhibit II-3. Both the profit after tax and cashflow increase by less than the full amount of the subsidy due to the impact of taxes. As long as PCW market prices remain below $20 per ton, the $6 per ton subsidy delivers less dollars to the PCW user than the 30% of purchase price subsidy. The probable impact is that $6 per ton will tend to stimulate primarily lower grade (and lower valued) post consumer waste consumption, while the 30% subsidy will have its greatest impact on the consumption of higher grades. Thus, the per-ton subsidy insures that more of the least economically attractive grades of PCW are recycled. Because it does not fluctuate with price, cost of this subsidy is more easily predicted. It does not provide a hedge against the risk of price increases.

As with the 30% subsidy, the $6 per ton subsidy will be of more benefit in situations where a high percentage of post consumer waste can be used in the process. The need to differentiate post consumer waste from scrap is present with this subsidy as with the previous one.

75% Credit Subsidy to Users. This subsidy is designed to reduce the effective interest rate on qualified investment in PCW equipment. Qualified investment is defined here as the facility's total investment cost, times PCW input as a percent of all raw materials inputs. The subsidy evaluated here takes the form of a taxable cash payment equal to 75% of the interest cost on qualified investment. A direct Federal loan at 25% of the market rate would have virtually the same effect. Unlike most equipment subsidies or a direct loan, this subsidy's yearly payment could be made contingent on compliance with the goals of the program.

The effect of the subsidy on our hypothetical user's income statement is presented in Exhibit II-3. In this case, the credit subsidy is only applicable to one half the investment because only half of the raw material input is post consumer waste. The net effect of the subsidy on profit after tax and cashflow are less than the full amount of the subsidy due to the impact of taxes. As could be expected, the credit subsidy will have its highest impact on capital intensive systems with a high degree of post-consumer waste usage.

The major administrative problem with this and the other equipment-related subsidies which follow is definition of eligible plant and equipment.

25% Investment Tax Credit. This subsidy is a reduction in income tax liability, taken in the year an investment is made, equal to 25% of the qualified PCW investment. The income tax reduction is taken in addition to regular depreciation allowances. Qualified investment is taken as the percent of PCW material to all material used as production inputs, times the total investment.

For an example of how this subsidy would affect the income statement of our hypothetical user of post consumer waste, see Exhibit II-3. The profits and cashflow increase in the first year only and remain the same as in the base (pre-subsidy case)in the remaining years. The excess cash that is freed in the first year can be used for other investment, so that its net impact on a company extends far into the future. The fact that the subsidy is all delivered in the first year provides good leverage of Federal dollars since the cost of Federal borrowing is less than the cost of corporate borrowing.

In calculating the impact on profitability of this subsidy in the following sections, the "no subsidy" case was assumed to have no investment tax credit allowances. However, a 7 percent investment tax credit exists at present for virtually all types of equipment investment.

Five Year Accelerated Depreciation. This subsidy allows users of post consumer waste to depreciate their qualified investment on a straight line basis over 5 years. The net effect is to decrease income tax liability (and increase cash flow) over the first five years of the investment, and increase tax liability (and decrease cash flow) over the remaining useful life of the equipment.*

For an illustration of how this subsidy would be calculated, see its effect on our hypothetical user in Exhibit II-3. Cashflow increases in years 1-5 because of decreased tax liability, while it decreases in years 6-20. The total cashflow over the life of the plant, and the total taxes paid remain the same. Because the extra cash generated in early years can be invested elsewhere, accelerated depreciation is clearly preferable to ordinary depreciation. Corporations may be reluctant to use accelerated depreciation because it lowers reported earnings figures. However, the majority of corporations keep two sets of books -- financial accounting for reporting to stockholders uses "fair" value for depreciation based on economic lives; and a tax accounting system for reporting to the IRS. This practice, allowed by the IRS, is designed to take advantage of accelerated depreciation and other tax incentives to minimize the current year's tax payment.

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* Users currently have the option of using other forms of accelerated depreciation (sum of year's digits, declining balance).

It should also be noted that while our analysis assumed straight line depreciation for the "no subsidy" case most firms already use presently allowed forms of accelerated depreciation such as double declining balance. However, the impact of double declining balance is less than that of 5-year accelerated depreciation.

Impact of Subsidies on Investment Models

In order to assess the subsidies' effects on profitability of the waste-using segments of the paper, steel, and glass industries, investment/income models were developed. The segments of each industry for which models were developed are shown below.

Paper	Steel	Glass
Linerboard Mills	Mini-Mills	Bottle Making Plants
Corrugating medium mills	Detinning Plants	
Folding Boxboard mills		
Newsprint mills		
Tissue mills		

In each instance the mills or plants defined are waste-using facilities in those segments of the industry where waste materials are most likely to be used. In the Appendix A, investment/income models are presented with a discussion of waste use in the industry. The effects of the various subsidies on the users' internal rates of return* are presented below in Exhibit II-4.

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*Internal rate of return is the rate of return on investment at which the cash flows over the life of the project discounted at this rate will equal zero.

EXHIBIT II-4

EFFECTS OF SUBSIDIES ON INTERNAL RATES OF RETURN

	Corrugating Medium	Combination Linerboard	News	Tissue	Mini-Mill	Detinning	Glass
No Subsidy	9%	4%	3%	NEG*	8%	9%	12%
$6/Ton Input	11%	8%	5%	NEG	9%	17%	16%
30% of Purchase Price	12%	10%	7%	13%	8%	17%	16%
75% Credit Subsidy	12%	9%	8%	NEG	9%	14%	15%
25% Investment Tax Credit	12%	8%	6%	NEG	8%	14%	19%
5-Year Accelerated Depreciation	11%	5%	4%	NEG	8%	11%	14%

* NEG = negative return on investment

Maximum Potential for Increased Waste Use

This segment of the analysis sets upper and lower limits to the potential subsidy impact establishing the users' total capacity to use waste as a raw material and the expected waste use without a subsidy. The steps in this determination are described below. Appendix A provides some of the background information which went into this analysis. A hypothetical industry "Maximum Potential Impact" graph is shown in Exhibit II-5. The elements of the graph are described below.

The first step is to determine future anticipated production in the three industries under consideration - paper, steel, and glass. Industry representatives were the principal sources consulted to develop this data. Since the industries considered are well established, their output is closely tied to population growth, and is relatively predictable. No major departures from historical trends over the next 13 years in any of the industries are predicted.

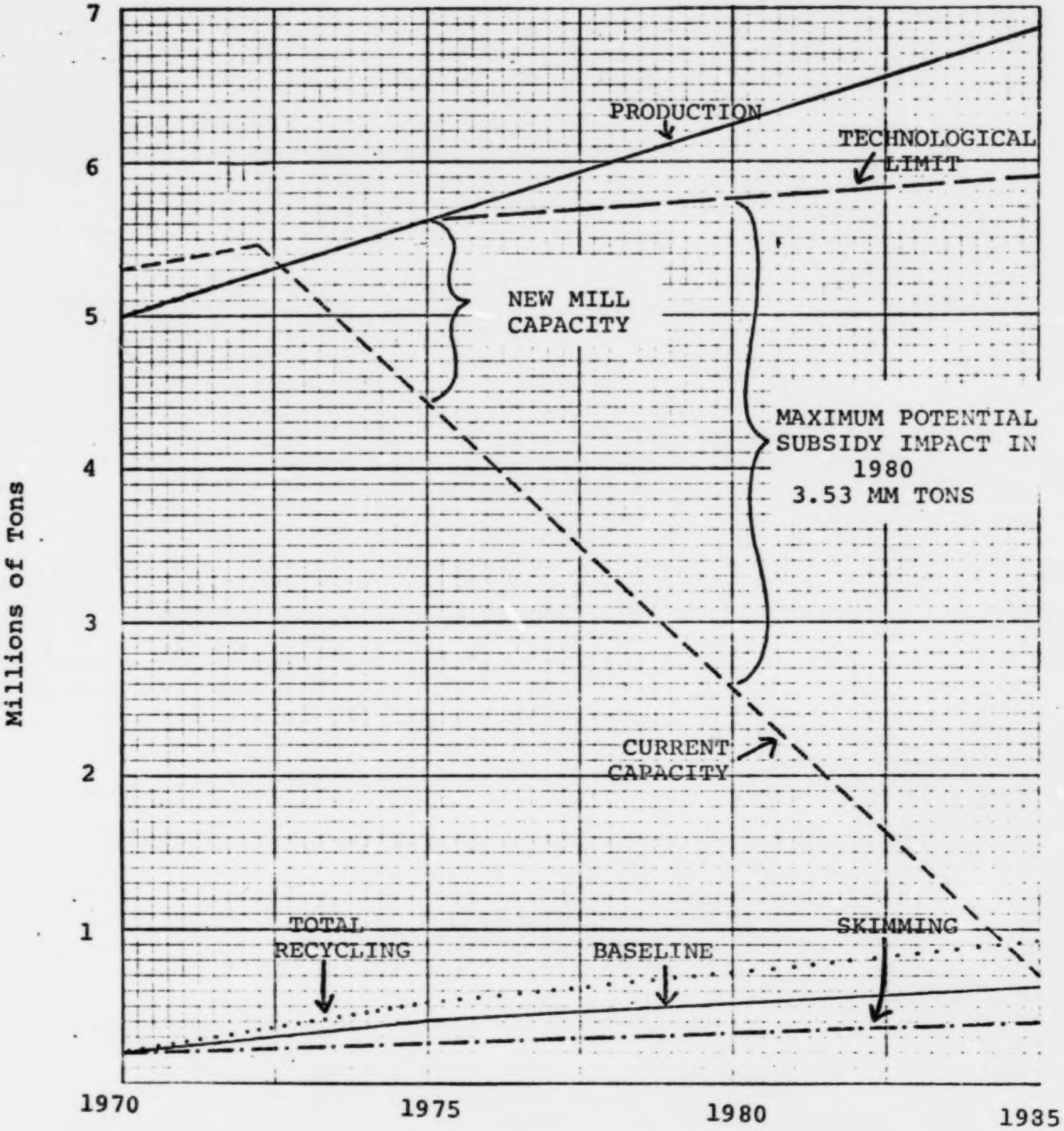
The second step involves estimating the rate of new equipment additions in the industries. The industries analyzed are all high fixed cost, capital intensive industries, and it is assumed that the decision to use PCW is made when new capacity must be added because of equipment obsolescence or increased demand. Other factors such as location can play a major role in the choice between using PCW and virgin raw materials. For example, in the paper industry, a location near forest but away from population centers may severely limit the use of PCW because of the high cost of shipping PCW raw materials.

The short, dashed line in the Hypothetical "Industry Maximum Potential Impact" graph illustrates the current production capacity. This was calculated by dividing the industry's capacity by the average economic life of equipment to establish a rate of obsolescence. The difference between a point on this curve and a point on the production curve in any year yields the total capacity that could theoretically switch to PCW.

The third step is to estimate the degree to which the industry already intends to use recycled materials. The objective of this study is to determine the incremental impact of a subsidy and therefore it was necessary to

EXHIBIT II - 5

HYPOTHETICAL INDUSTRY MAXIMUM POTENTIAL IMPACT



develop a level of recycling to act as a base for estimating increments. Industry forecasts, and discussions with industry representatives were used to develop this data for each industry. In the Hypothetical "Industry Maximum Potential Impact" graph, Exhibit II-5, the anticipated use of PCW without a subsidy is illustrated by a dot-dash line. The baseline recycling estimates for paper, steel, and glass are presented with the subsidy impact estimates in Appendix C.

The next step is to determine the technological limits to recycling. Attempts to increase recycling above the technical limit can only result in inefficient use of the subsidy. Technical reports and discussions with industry representatives were used to develop this data for each industry segment. In some cases, the technical limits to recycling are unknown; and in others technical advances are in the form of proprietary processes which are not available to the general public.

The maximum potential impact of a subsidy is the vertical distance between the lower of the production line or technological limit line and the higher of the obsolescence line or the planned recycling line as shown on the graph. For our hypothetical industry, the maximum potential impacts in the years 1975, 1980, and 1985 are approximately 1.2 million tons, 3.5 million tons, and 5.2 million tons respectively.

Predicting Subsidy Impact

The methodology developed by RPA to estimate the effectiveness of subsidies to users of post-consumer waste is a mathematical simulation technique that gives point estimates of the impact of given subsidies in the years 1975, 1980, and 1985; the predictions obtained assume that the subsidy was initiated in late 1972, and that the subsidy was administered in such a way as to be understood and used for the intended purpose.

So far in the analysis, determination has been made of the impact of the subsidies on plant profitability and of the upper and lower bounds of potential subsidy impact on investment. Both of these factors could be fairly straightforwardly quantified given reasonable data. This part of the analysis provides a model for combining the impact on plant profitability with the potential investment impact to determine a "best estimate" of actual influence on industry investment and thus of increased recycling. The question asked here is: "As return on investment changes on facilities using waste materials, how will the investment in waste-using capacity change relative to investment in other (virgin materials using) capacity?"

The following steps were used to make this determination:

1) Investment profile: An industry's investment profile is the percent of an industry segment's capacity replacements and additions that would be waste-using facilities at any given return on investment.

2) Risk profile: The extent to which the investments suggested by this investment profile would be altered by the business risk associated with the unusual fluctuation in and uncertainty of secondary material price, i.e., an adjustment based on the probability that the return on investment will be other than that expected because of a change in secondary material price.

3) Learning curve: The extent to which the investment suggested by the two above steps would change over time as more experience with use of post consumer waste is gained.

4) Equilibrium position: The above three steps assume perfectly elastic supply, i.e., no price increases in post consumer waste despite the increased demand brought about by the subsidy. Based on estimates of supply inelasticity and the above demand estimates a market equilibrium is established.

Appendix B provides an example of the application of the prediction methodology to the newsprint segment of the paper industry.

Investment Profile

The methodology was based on the hypothesis that, in the absence of outside forces, the industries in question will continue to act as they have acted in the past. A Federal subsidy to stimulate resource recovery would be an outside force acting, through economics, to stimulate greater use of post consumer waste. The first step in assessing the shift in preference was to calculate the economic effects of specific subsidies on the profitability of plants using post consumer waste. The second step was the construction of the investment profile.

If a subsidy is granted, the economics of a PCW-based plant will change, and the internal rate of return will be raised. The question then becomes whether the increase in the IRR is a sufficient incentive to switch from virgin to PCW uses.

The percent of capacity decisions that would be made in favor of PCW use can be expressed as a monotomically increasing function of the internal rate of return. Decision makers who are now using virgin input tend to view the use of post consumer waste in light of various business factors. These factors involve the marketing and production structure in the industry, historical biases toward virgin materials, and customer requirements which foster an attitude favorable to virgin raw materials. Generally, a higher potential rate of return is necessary to persuade an investor to change his and his customer's attitude and compensate him for performing R & D to overcome production problems.

An example of an investment profile is shown in Appendix B. This investment profile is an assessment of the percent of new capacity which will use post consumer waste at each IRR, considering all business factors except risk associated with PCW price and supply.

An original investment profile curve was generated by assessing the investment decision process of firms in the industry by analysis of the internal rates of return necessary (i.e., hurdle rates) to sway a capacity decision in favor of PCW use. It is assumed here that none will invest in PCW-based mills at internal rates of return less than the stated required corporate internal rates of return for new investment. Most of our industry sources indicate that this minimum IRR is 15 percent, while for the glass manufacturing industry it is 20 percent.

The curves were adjusted following the same logic as in the original to reflect the rates of return that that industry has historically experienced rather than the stated hurdle rates. The adjusted curves were used in the final predictions of subsidy effectiveness. The following factors are some of those which were considered in the final development of the curves.

- The quality requirements and reliability of supply of virgin raw materials.
- The consumer's sensitivity to the product's raw material makeup.
- The economies of scale at the plant level.
- The decision makers' experience with PCW.
- The projected long-run strength of the industry or sub-industry.

The shape of the curves for each industry segment followed the traditional "s" shape though there was considerable variation among industries.

Risk Profile

The risk profile takes into account the factors of PCW price and supply not covered in the investment profile. In order to assess the attitude of different industries toward PCW input price and supply risk, we have developed a measure which illustrates our judgment of this sensitivity. This is a means of quantifying the extent to which investments are discouraged by the uncertainty resulting from the historical price fluctuations in secondary materials.

A maximum risk potential was calculated as the percentage change in IRR that would result from a 25% increase in PCW price. It was calculated by subtracting the expected IRR from the IRR when the price of PCW rises to 125% of its present level, divided by the expected IRR. The results, expressed as a percent, constitute a maximum downside risk factor as viewed by the industry.

The shape of the risk profile curves were generally similar to the newsprint curve shown in Appendix B.

The following are some of the considerations which went into the formation of these curves.

1. The historical variance of an industry's return on investment (essentially, decision maker's ability to live with risk). The lower the variance of return on investment, the greater number of decision makers there will be who would be risk averse.

2. Familiarity with PCW in the production process. The more familiar the decision makers are with the price and supply problems of PCW, the greater would be the acceptance of PCW in the future. Conversely, an industry used to steady, reliable supply from integrated sources would be risk averse.

3. Present state of development of PCW supply sources. This factor includes an assessment of the nature of supply. A supply based almost exclusively on proper home separation (glass bottles, for example) is less attractive than one based on simple technology (magnetic separation of ferrous cans) because of the uncertainty of supply involved in home separation programs.

4. Susceptibility to economic business cycles. These factors include the historical price and supply behavior of the PCW materials considered. Wild price and supply changes lead to more risk aversion than to historically steady performance.

5. Perceived industry bargaining strength versus PCW supply sources. It is important to remember that to a large extent, the user industries will be dealing with a new supply source, the municipalities. Total reliance on this supply source is more risky than cases in which alternative sources of supply can be utilized in the event of a breakdown in the new supply source - user industry relationships.

Learning Curve

The learning curve is nothing more than an assertion that as experience is gained with use of post consumer waste and risks associated with its use are lowered the "Investment" and "Risk" profiles would be slightly more positive. Rather than reconstruct these curves for future years a positive multiplier was established through the application of the learning curve factor.

Equilibrium Solution

The methodology up to this point predicts what would happen if all decision makers acted in isolation, i.e., if supply were perfectly elastic. However, competition and economics would play a role, and as demand increased, the price of scrap would increase.

To correct this, we sought to judge what would be the "economic equilibrium". Some of the subsidy must be passed back to suppliers in higher priced industries to stimulate more supply. This action in turn lowers the amount of subsidy that the user industry keeps, dampening his demand, and so on until all demand is satisfied at a somewhat higher price.

The problem of determining the equilibrium position can theoretically be solved using supply and demand curves. Although the data generated by the models and analysis appear to lead logically to the construction of supply and demand curves for the recovered materials, this would yield elaborate but incorrect results. The supply curves for the recovered materials are interdependent. A resource recovery plant produces more than one type of recyclable material. Thus, it would be inappropriate, as theory for independent commodities in free market says, to shift the supply surve of a particular recycled material by the amount of the subsidy.

To estimate an equilibrium solution, bounds were set representing estimates of both supply and demand. This requires the compilation of supply elasticity data for each of the PCW commodities considered. To our knowledge, such data does not exist and developing it was well beyond the scope of this study. Therefore, estimates were made as to what these elasticities would be, based on knowledge of secondary materials supply mechanisms.

A simple linear equation was used to estimate the equilibrium price and quantity of increased consumption. While the equation and the equilibrium methodology as a whole are oversimplifications and approximations, they are a reasonable approach short of a detailed economic study.

The equilibrium equation used varied by subsidy. An example is shown in Exhibit II-6.

Results of Subsidy Analysis

The objective of the study was to develop predictions of the effect of a variety of subsidies on the use of PCW paper, cans and glass by segments of the paper, steel, and glass industry. These predictions should provide policy makers with the quantitative data base to which could be added the more subjective evaluations. The time frame chosen for evaluation was 1976 to 1985.

The results are presented in the Exhibits II-7 through II-10. Each chart is relatively self-expanatory. The notes refer to descriptions of each element on the charts. Appendix C presents a more detailed breakdown of the results, including year by year data by material on baseline recycling and incremental recycling.

The conclusions that could be drawn from the following exhibits are by no means obvious, and there are some observations which should be made.

Windfall, or subsidization of recycling which would have occurred anyway, is about 60 percent in all cases, which makes all of the subsidies appear inefficient. The windfall for the subsidies depends on the amount of incremental recycling induced as well as the extent to which existing (baseline) recycling is subsidized. For the 30% operating subsidy a relatively large incremental recycling is induced but subsidy is paid for all of the baseline recycling as well. The capital subsidies induce less new recycling but also subsidize much less of existing recycling since they are based on equipment purchase, and baseline recycling uses primarily existing equipment. There is not complete agreement, however, on how "bad" windfall is in any case. Some industry representatives argue that any subsidy which does not allow payments for existing recycling could be counter-productive

EXHIBIT II-6

USER SUBSIDY EUQILIBRIUM SOLUTION MECHANISM

$$\overset{A}{\begin{pmatrix}\text{resource re-}\\ \text{covery plant}\\ \text{supply per}\\ \text{dollar of}\\ \text{price increase}\end{pmatrix}} \cdot \overset{B}{\begin{pmatrix}\text{unknown}\\ \text{equilibrium}\\ \text{price}\\ \text{increase}\\ \text{=X}\end{pmatrix}} + \overset{C}{\begin{pmatrix}\text{skimming}\\ \text{supply per}\\ \text{dollar of}\\ \text{price}\\ \text{increase}\end{pmatrix}} \cdot \overset{D}{\begin{pmatrix}\text{X}\end{pmatrix}} = \overset{E}{\begin{pmatrix}\text{demand if}\\ \text{users re-}\\ \text{tained all}\\ \text{of subsidy}\end{pmatrix}} - \overset{F}{\begin{pmatrix}\text{decline in}\\ \text{user demand}\\ \text{per dollar}\\ \text{price}\\ \text{increase}\end{pmatrix}} \cdot \overset{G}{\begin{pmatrix}\text{X}\end{pmatrix}}$$

Notes

A. Derivation: A = incremental supply over baseline if processors retained the \$6/ton subsidy ÷ \$6.

B. Term B is the unknown price change for which we are solving.

C. Term C is Term A multiplied by the ratio of skimming elasticity of supply to resource recovery plant elasticity of supply. The ratio is an estimate.

E. Term E is the incremental user demand over baseline skimming plus resource recovery plant output given perfectly elastic supply and the \$6/ton subsidy.

F. Term F derived as follows:

$$F = \left(E \div \begin{array}{l}\text{effective price decrease necessary to}\\ \text{induce demand E; i.e., dollar amount of}\\ \text{the subsidy with perfectly elastic supply, \$6/ton.}\end{array} \right)$$

Solution

X = price increase to reach equilibrium

(A) • (X) = incremental output of resource recovery plants above baseline

(C) • (X) = incremental skimming above baseline

(A+C) • (X) = total incremental recycling above baseline

Equation assumes that the ratio of skimming supply elasticity to R.R. plant supply elasticity remains constant over the relevant range.

Specific values of equation terms are year-determined.

because existing firms could be put in a disadvantageous competitive position by new firms. In this analysis subsidy for existing recycling was assumed to provide no additional benefits, but in reality it would have to improve the competitive position of waste material users and might have some positive effects on recycling. Nevertheless, high windfall generally indicates that a large portion of subsidy dollars are not going toward achievement of the legislative intent.

Comparing the subsidies is complicated by the fact that the levels of the subsidies examined are not equivalent. A 30 percent operating subsidy delivers more dollars to the recipient than the other subsidies. The five-year amortization delivers less subsidy than any of the others. The cost per ton of incremental recycling would seem to be a reasonable comparison index for the subsidies, but by itself is far too simplistic. Practical factors would have to be taken into account. For example, it may be that defining equipment which uses post-consumer waste would be extremely complex, and that in the end the subsidy would not be for the exact equipment assumed here, making the cost of the subsidy higher or lower. Defining post consumer waste for the operating subsidies is generally thought by industry to be easier than defining eligible equipment, but a similar problem could arise.

Looking at the subsidies by material it is obvious that paper would be by far the major component of new recycling. This stems in part from the fact that paper comprises a larger fraction of the waste stream, but also the supply system for waste paper is much more developed than the supply systems for glass and cans, both of which depend to a significant degree on existence of resource recovery plants to process mixed waste. Also, the relative impact of different subsidies differs for the different materials because of the industry characteristics. None of the subsidies was particularly effective for glass recycling because supply, not demand, seems to be the primary inhibitor of recycling.

The results indicate that to get a significant increase in recycling a relatively large subsidy is required. A 5 year amortization, for example, would increase recycling by only an estimated 12 percent because its subsidy benefit is not large. It may well be, however, that a measure such as this, which has a very low cost per ton of new recycling, is a far more prudent measure than the other subsidies.

Limitations of the study predictions should certainly be considered in interpreting the results.

One important factor impacting on the results is data validity. Data on production costs is not readily obtainable from industry in any detail and varies from situation to situation. It also varies over time as economic conditions change. The economic conditions reflected in the user cost models in this study are the conditions of 1 to 2 years ago. A number of economic events have occurred since that time: various prices have been frozen and released; a Canadian mill strike has placed a premium on waste news as a raw material, substantially increasing prices; prices of all waste paper have more than doubled; paper companies using virgin materials have been hit by raw material shortages and have found ways to increase mill capacity by using waste paper; an export control system on scrap steel may have set limits to that industry's short term plans; concern for recycling has increased, witnessed by the fact that about 70 home separation systems have been implemented since September, 1972. Most of the above trends, if found to be long term in nature, will act to change our predictions of recycling, both the baseline predictions and the estimates of subsidy effectiveness.

A second major factor is the validity of the prediction methodology. In the absence of data on price elasticity of supply and demand it was necessary to try to model the investment decision process of industry. Obviously decision criteria vary from company to company as do aversion to risk, investment hurdle rates, and other factors. The methodology used was based on careful industry analysis but must be considered a rather crude approximation of the real world. We do believe that it gives reasonable estimates bounded by maximums and minimums which give the decision maker a good feel for what the effect of the subsidies would be. To read a greater degree of accuracy into the data would be a mistake.

EXHIBIT II-7

SUMMARY RESULTS OF SUBSIDY IMPACTS

TOTAL 1976-1985		30% of Purchase Price	$6 Per Ton of Input	25% Investment Tax Credit	5-Year Accelerated Depreciation	75% Credit
Note 1	Incremental Recycling (000,000 tons)	50.9	32.3	32.0	15.5	37
Note 2	Total Cost to Federal Government (000,000$)	1,378	843	347	102	810
Note 3	Cost per Incremental Ton	27.00	26.10	10.84	6.58	21.90
Note 4	Incremental Increase in Recycling (%)	48	30	30	15	35

EXHIBIT II-8

SUMMARY RESULTS OF SUBSIDIES TO WASTE PAPER USERS

PAPER 1976-1985		30% of Purchase Price	$6 Per Ton of Input	25% Investment Tax Credit	5-Year Accelerated Depreciation	75% Credit
Note 1	Incremental Recycling (000,000 tons)	43.7	22.8	23.0	11.9	29.4
Note 2	Total Cost to Federal Government (000,000$)	1,289	728	305	95	734
Note 3	Cost per Incremental Ton	29.50	31.94	13.26	8.02	18.65
Note 4	Incremental Increase in Recycling (%)	45	23	23	12	30
Note 5	Windfall (%)	69	81	61	79	68

EXHIBIT II-9

SUMMARY RESULTS OF SUBSIDY TO CAN USERS

CANS 1976-1985		30% of Purchase Price	$6 Per Ton of Input	25% Investment Tax Credit	5-Year Accelerated Depreciation	75% Credit
Note 1	Incremental Recycling (000,000 tons)	5.6	8.6	7	3.1	6.6
Note 2	Total Cost to Federal Government (000,000$)	47	78	23	7	45
Note 3	Cost per Incremental Ton	8.42	8.86	3.26	1.78	6.85
Note 4	Incremental Increase in Recycling (%)	160	250	206	91	194
Note 5	Windfall (%)	43	32	31	44	35

EXHIBIT II-10

SUMMARY RESULTS OF SUBSIDY TO WASTE GLASS USERS

GLASS 1976-1985		30% of Purchase Price	$6 Per Ton of Input	25% Investment Tax Credit	5-Year Accelerated Depreciation	75% Credit
Note 1	Incremental Recycling (000,000 tons)	1.6	0.9	2	0.5	1
Note 2	Total Cost to Federal Government (000,000$)	42	37	19	0.2	31
Note 3	Cost per Incremental Ton	25.70	43.41	9.74	0.44	32.55
Note 4	Incremental Increase in Recycling (%)	30	17	37	9	19
Note 5	Windfall (%)	77	86	55	82	76

Notes to Exhibits II-7 Through II-10

Note 1 - Incremental Recycling

The incremental recycling is the increase in recycling above the baseline which will result from a subsidy. With one exception, the results presented above were obtained through application of the methodology described earlier in this section. As the discussion up to this point has indicated the underlying assumption of the analysis was that increased recycling required investment in new facilities, probably in different locations than those using virgin materials. On the whole this assumption fits actual industry patterns; however, an exception for the paper industry seemed necessary. Some paper industry segments which use primarily virgin raw materials in "wood pulp based" products use a small percentage of recycled fiber in their furnish. The Kraft linerboard and printing-writing paper segments of the industry, which represent a fairly significant percentage of industry output, have a potential for increased waste use which would be influenced by a subsidy. Estimates of increased waste paper usage in virgin-based facilities were provided by the EPA and based primarily on a report to the American Paper Institute.[1] The breakdown between new investment in wastepaper-based facilities and additional usage in virgin-based plants is presented below. The result presented in Exhibit II-8 are the combination of both impacts.

Increase in Recycling
(000 tons)

Subsidy	1975		1980		1985	
	New Investment	PCW Addition	New Investment	PCW Addition	New Investment	PCW Addition
30% of Purchase Price	1,130	252	3,607	540	5,895	840
$6/ton of input	599	117	1,899	265	3,101	419
25% Investment Tax Credit	435	117	1,422	265	2,322	419
75% Credit	770	161	2,430	355	3,973	560
5-yr Accel. Depr.	323	30	1,015	113	1,648	186

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[1] Paper Recyling: The Art of the Possible, American Paper Institute, 1973.

Note 2 - Cost to the Federal Government

The caluclation of the cost to the Federal Government varies by subsidy but the cost basically reflects the net income transfer from the Federal government to all subsidy recipients. The overall cost analysis would also include additional (lost) tax revenues, administrative costs and induced economic inefficiencies created by the reactions to the subsidy.

The cost to the government of the input subsidies (30% of purchase price and $6 per input ton) equals the amount of the subsidy multiplied by the total number of tons of PCW used, the cost of the 75% credit subsidy equals 75% of the total interest expense incurred in the purchase of capital equipment times the percent of PCW in the raw material input. The Federal commitment for this subsidy continues as far as 2005 in some cases because of the residual commitment on 20 year loans made during the target period 1975-1985. The cost of the 25% investment tax credit equals the cost of capital equipment times the percentage of PCW in the raw material input times 25%. The cost of 5-year accelerated depreciation equals the discounted value of the cash flow lost to the government as a result of lower taxes paid using the accelerated depreciation versus currently used methods.

The calculation of the net income transfer does not take into account possible increased tax revenues that might be generated because of the increased profitability of subsidy recipients. The amount is rather small, and the calculation is subject to the vagaries of accounting systems.

Note 3 - Cost per Incremental Ton

This figure equals the cost to the government (2) divided by the incremental recycling (1). It provides a relative measure of the efficiency of the subsidy.

Note 4 - Incremental Increase in Recycling

This figure equals the incremental recycling divided by the baseline recycling that is projected to take place in the absence of a subsidy.

The following table presents the baseline figures used in this study. They are for post consumer waste only. Skimming refers to material recycled through source separation programs. Resource recovery plants refers to material recycled from large scale resource recovery plants.

Baseline

Material	Year	Skimming (000 tons)	Resource Recovery Plants (000 tons)	Total (000 tons)
Paper	1975	8258	82	8340
	1980	9509	151	9660
	1985	10951	263	11220
Cans	1975	86	135	221
	1980	116	246	362
	1985	210	431	641
Glass	1975	261	92	353
	1980	333	168	501
	1985	425	294	719

Note 5 - Windfall

The windfall figure represents the percentage of the total cost of the subsidy that the Federal government pays out to recipients that would have added capacity that uses PCW anyway. It is a measure of the efficiency of the subsidy. The higher the windfall the lower the efficiency.

The windfall is calculated by dividing the cost of subsidizing the baseline by the total cost to the government of a particular subsidy.

Subsidies for Construction of Municipal Resource Recovery Plants

Outline of Prediction Methodology

An alternative to subsidizing demand for secondary materials is to subsidize supply. Subsidization of traditional suppliers of waste materials, i.e., the salvage industry, is really closely akin to subsidizing demand in that both the suppliers and users will ultimately receive a part of the subsidy through the normal functioning of the market. In the case of the demand subsidies just examined it was determined that part of the subsidy would be "bid away" as the price of secondary materials increased as a result of increasing demand.

A totally different approach to supply subsidization is a direct subsidy to municipalities for construction of resource recovery plants, i.e. large processing/recovery facilities for recovery of materials or energy. This segment of the report discusses subsidies to municipalities for construction of such plants.

The methodology for evaluating the impact of the subsidies is somewhat similar to that used to evaluate demand subsidies. There are three basic steps:

(1) Cost Impact - Determine the impact of each subsidy on the cost of recovery from each plant type.

(2) Plant Potential - Determine the maximum potential for plant construction and the expected number of plants to be built without the subsidy.

(3) Actual Subsidy Effectiveness - Predict the number of plants which would be built with each subsidy.

Outline of Subsidies and Their Cost Impact

A subsidy to municipally-owned resource recovery plants is intended to make resource recovery less expensive, and hence more attractive for municipalities. To examine the impact of a subsidy on such a plant, and to illustrate the calculation necessary to view the impact of the subsidy we will use cost projections for a hypothetical recovery plant. This plant recovers both energy and materials. The investment cost categories require some clarification. (See Exhibit II-11.)

Typically, a municipality will purchase a processing facility through the use of bonded debt rather than out of a general operating budget. There are two major reasons for using this form of financing. First, the purchase of a processing system almost always represents a substantial dollar cost. The ability of a municipality to pay for an expensive system out of one year's tax revenues is limited. Secondly, by purchasing the system through bonded debt with equal sinking fund payments, it is thought that the costs of owning the system will be spread equitably over those who benefit from the system's use. Any year's sinking fund payment is paid by that year's general tax revenues, which in turn are paid by the residents of a municipality in that year.

There are three separate categories of items that must be financed before a municipality can expect to have an on-going system. In our analysis of subsidies, these items are termed recoverable (non-depreciable), amortized, and fixed investment. Recoverable investment consists of those items for which it is assumed that their use constitutes no loss of economic value. The major component of the category is land, which may be sold after the economic life of the processing system is exhausted. The costs associated with recoverable assets is interest on the principle amount borrowed to finance the purchase. This assumes that the principle amount is repaid by selling the recoverable assets.

Fixed assets represent the actual hardware of the recovery system. This item makes up the bulk of the installed cost of resource recovery plant, and is financed by bonded debt. The cost associated with this category of assets is composed of the principle and interest components of the debt structured in such a way as to result in constant annual payments. The resulting effect is exactly analogous to conventional home mortgages.

EXHIBIT II-11

HYPOTHETICAL RESOURCE RECOVERY PLANT

PARAMETERS:

1,000 TONS PER DAY INPUT CAPACITY, OR 300,000 TONS PER YEAR

FIXED INVESTMENT REQUIRED: $6,200,000
AMORTIZED INVESTMENT REQUIRED: $1,500,000
RECOVERABLE INVESTMENT REQUIRED: $700,000
ENERGY SALES PER YEAR: $150,000
MATERIAL SALES PER YEAR: $80,000
TONS OF MATERIAL SOLD: 8,000 T
OPERATING EXPENSES PER YEAR: $200,000
ECONOMIC OPERATING LIFE: 20 years

	TOTAL ANNUAL	PER INPUT TON
REVENUES		
Material sales	$ 80,000	$ .27
Energy sales	150,000	.40
TOTAL REVENUES	$ 230,000	
COSTS		
Operating costs	$ 200,000	$ .67
Fixed Investment Costs[1]	497,504	1.66
Amortized Investment Costs[2]	346,462	1.15
Recoverable Investment Costs[3]	35,000	.12
TOTAL COSTS	$ 1,078,966	$ 3.60
NET COSTS	$ 848,966	$ 2.83

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[1] Annual payment sufficient to amortize a 20 yr.,5% loan for 6,200,000.

[2] Annual payment sufficient to amortize a 5 yr.,5% loan for 1,500,000

[3] Interest only at 5% on $700,000.

EXHIBIT II-12

HYPOTHETICAL RESOURCE RECOVERY PLANT WITH APPLICATION OF SUBSIDIES

	PRE-SUBSIDY		30 PERCENT OF SALES SUBSIDY		$6 PER TON SUBSIDY		25 PERCENT CONSTRUCTION GRANT		50 PERCENT CONSTRUCTION GRANT		75 PERCENT CONSTRUCTION GRANT		75 PERCENT CREDIT SUBSIDY	
	total annual	per ton	total annual	per ton	total annual	per ton	total annual	per ton	total annual	per ton	total annual	per ton	total annual	per ton
REVENUES														
Material Sales	80,000	.27	104,000	.35	128,000	.43	80,000	.27	80,000	.27	80,000	.27	80,000	.27
Energy Sales	150,000	.50	195,000	.65	150,000	.50	150,000	.50	150,000	.50	150,000	.50	150,000	.50
TOTAL REVENUE	230,000	.77	299,000	1.00	278,000	.92	230,000	.93	230,000	.77	230,000	.77	230,000	.77
COSTS														
Operating Costs	200,000	.67	200,000	.67	200,000	.67	200,000	.67	200,000	.67	200,000	.67	200,000	.67
Fixed Investment costs	497,504	1.66	497,504	1.66	497,504	1.66	373,128	1.24	248,752	.83	124,376	.41	352,286	1.17
Amortized Investment Costs	346,462	1.15	346,462	1.15	346,462	1.15	346,462	1.15	346,462	1.15	346,462	1.15	311,343	1.04
Recoverable Investment Costs	35,000	.12	35,000	.12	35,000	.12	35,000	.12	35,000	.12	35,000	—	8,750	.03
TOTAL COSTS	1,079,966	3.60	1,078,966	3.60	1,078,966	3.60	954,590	3.18	830,213	2.77	705,838	2.35	872,379	2.91
NET COSTS	848,966	2.83	799,966	2.60	800,966	2.67	724,590	2.42	600,214	2.00	475,838	1.59	642,379	2.14

The last category is referred to as amortized investment. This is composed chiefly of front-end planning, research and development, and engineering. Like fixed investments, amortized investment has cost components consisting of principle and interest payments paid in equal annual installments. Generally, we considered a five year economic life for this category of assets.

Besides the capital charges referred to above, the resource recovery system will incur variable operating costs consisting of items such as labor, administration, fuel utilities, and the like. Operating revenues will be generated through the sale of recovered materials and energy.

The analysis included the impacts of four different kinds of subsidies. The effects of these subsidies on the hypothetical recovery plant are shown in Exhibit II-12.

Percent of Sales Subsidy

A percent of sales cash subsidy takes the form of a non-taxable cash payment from the Federal government to the municipality. The amount of the subsidy is equal to a fixed percent of the revenue generated by the sale of material or energy after recovery from the waste stream. Our projections are based on a 30% subsidy.

To illustrate the effect of a 30% sales subsidy, see Exhibit II-12, where the subsidy is applied to the hypothetical plant. For the hypothetical plant, the subsidy reduces net cost per ton to 92% of its former value, and represents an increased cashflow to the municipality of $69,000 annually. Since the subsidy is tied to output, its greatest effect is on systems that have low capital investment and high revenues from sale of recovered resources. Since the subsidy is based on selling price, there is a positive incentive to process PCW into a form dictated by the demands of the market place. The more effective the marketing, the larger the sales price received, and the larger the subsidy.

Another effect of the subsidy is a productivity change. The subsidy rewards highly priced goods much more than low prices goods. The marginal cost of processing a particular type of waste for sale would be weighed against the marginal revenue (plus subsidy) gained. We believe that the net effect would be to stimulate more material recovery oriented systems (mechanical separation) over energy, recovery systems. An advantage of this subsidy is that it is easily understood and has short lead time for implementation.

Per-Ton Cash Subsidies

A per-ton cash subsidy takes the form of a non-taxable cash payment from the Federal government to the municipal processor. The amount of the subsidy is determined by the number of tons of recovered material sold, times the subsidy ($6 per ton in this analysis).

A per-ton subsidy percentage-wise delivers more subsidy dollars to low quality, low price material outputs than to higher-priced, harder to obtain materials. This is in one way beneficial since lower valued materials are often those which cannot be economically recycled. However, there would also be little incentive to upgrade the quality of processed waste. There would be a tendency to produce high volume, low value outputs such as compost. Only market demand would act to require high quality PCW output. Because of this, standards for outputs would have to be set and enforced which could make the administrative costs of this subsidy high.

Construction Grants

A construction grant is a cash payment from the Federal government to a municipality based on a percent of the purchase price of hardware. Our analysis looked at the effects of 25 percent, 50 percent, and 75 percent construction grants.

Construction grants, as a one-time, non-refundable payment to the municipality, reduce their overall costs regardless of the markets for their output. This reduces the inherent risks and thus encourages the purchase of a resource recovery system.

There are a number of major caveats attributable to construction grants, as with all capital subsidies. First, construction grants tend to encourage inefficient capital solutions. Previous capital subsidies (in the transportation and maritime industries) have resulted in decidedly overcapitalized technology, inadequate maintenance, and premature replacement. Secondly, previous capital grants have been awarded on a readiness to proceed basis, with little analysis as to the economic feasibility of a subsidized facility. Thirdly, it is difficult to ensure that the legislative intent will be carried out. For instance, if an incinerator with waste heat recovery is built, there is no guarantee that the steam will be produced or sold. The subsidies might be a way for a municipality to build a cheaper incinerator.

The above problems make effective administration of the program critical to its success. A proper administration would require both technical expertise and executive capability. Technical expertise would be necessary to assess the risks of any experimentation and overall technological feasibility of proposed projects.

The executive function would consist of seeing that proposed facilities implemented resource recovery, and assigning priorities for the awarding of grants.

Construction grants are most often used where it is thought that the target (the municipality) is capital poor. It is doubtful whether this is the case, as most municipalities seem to have unused debt capacity.[1] In this instance, the construction grant should be viewed as a device for encouraging experimentation with new recovery systems.

Credit Subsidies

The credit subsidy considered here is in the form of a direct loan from the Federal government to a municipality equal to the installed cost of equipment, the recoverable investment, and the amortized investment. The interest rate on the loan would be 75 percent less than the current market rate. Unlike the construction grant, the 75 percent credit subsidy was assumed to apply to all classes of capital; and, even though it is a 75 percent credit subsidy, capital charges to a municipality decrease by only 24 percent. This is because a large portion of annual debt service is repayment of principal rather than interest expense.

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[1] Assessment of Alternative Financing Methods for Solid Waste Facilities and Equipment, Resource Planning Assoc. Draft report to U.S. Environmental Protection Agency, 1973.

Credit subsidies, like construction grants, should be viewed primarily as a means of delivering a cost reducing subsidy rather than as a means to solve problems of obtaining capital, which as mentioned above does not appear a major deterrent to cities at present. However, by removing much of the burden of obtaining capital, it obviously has an appeal to cities.

Once the candidate for a credit subsidy has been selected, administrative details are relatively insignificant. Essentially, the Federal government acts as a bond trustee. Since municipalities, the debtor, have historically been very credit worthy, the risk of default on the loan is quite small.

The major administrative problem with this subsidy is similar to that of construction grants: namely, assuring that the goal of the subsidy (recovery of resources) will be met. Since the loan agreement is signed prior to operation, there is no assurance that recovered resources can or will be sold over the life of the project. This implies the need for a highly selective screening process carried out by a technically competent staff.

Outlays for a credit subsidy program are highly predictable at the time the loan agreement is signed. Additionally, while future costs of a specific project are fixed, ending new outlays should cause few problems.

Resource Recovery Systems

The six resource recovery systems used in this report as models are:

- Mechanical Separation
- Incineration With Residue Recovery
- Recovery for Supplemental Fuel
- Incineration with Steam Recovery

- Incineration with Electric Generation
- Pyrolysis

Appendix D contains a brief description of each of the six systems and presents a "no-subsidy" cost and revenue breakdown for each plant. The dollar figures on investment requirement, operating costs, and resource recovery revenues are all extracted from the U.S. Government document entitled "Resource Recovery, the State of Technology," published in February, 1973. There have been steady trends in the last couple of years which strongly indicate that many of the investment figures are low and, in some cases, substantially so. In addition, while cost projections often include revenues from the sale of such recovered materials as glass and non-ferrous metals, there are no full-scale operational systems which have demonstrated the ability to recover these materials from mixed municipal solid waste satisfactorily through recovery techniques are being developed and demonstration of one system recently began.

The figures from the aforementioned report are used here because they represent a single comprehensive basis for comparison. Development of this data was not part of the study being presented.

Exhibit II-13 indicates the effect on net cost per ton of operation of each subsidy for each model plant. It should be mentioned at this time that privately owned plants were not directly considered in this analysis but should not be ruled out as possible subsidy recipients. It was assumed that analysis on municipally-owned plants was representative of subsidy impact even if in actuality privately owned plants were eligible for the subsidy. In reality a number of these plants would undoubtedly be financed and operated by the private sector. For illustrative purposes Exhibit II-14 presents the net profit and internal rate of return of the six plants considered assuming private ownership. These calculations are based on data from the report previously mentioned. The costs appear less favorable than those for municipally-owned plants because of higher borrowing costs and property and income taxes.

EXHIBIT II-13

IMPACT OF SUBSIDIES ON THE ECONOMICS OF MUNICIPALLY OWNED RESOURCE RECOVERY PLANTS

(Net Annual Cost of Operation in $/Ton)

	MECHANICAL SEPARATION	RECOVERY FOR SUPPLEMENTAL FUEL	INCINERATION WITH RESIDUE RECOVERY	INCINERATION WITH STEAM RECOVERY	INCINERATION WITH ELECTRIC GENERATION	PYROLYSIS
No Subsidy	4.77	2.70	7.18	7.05	8.97	3.76
30% of Sales	3.45	1.78	6.64	6.05	6.99	3.76
$6/Ton Sold	3.10	2.30	6.56	7.05	8.97	4.66
25% Construction Grant	4.13	2.29	6.60	6.42	7.97	4.76
50% Construction Grant	3.49	1.88	6.01	5.79	6.96	4.07
75% Construction Grant	2.86	1.46	5.33	5.15	5.95	3.40
75% Credit	3.84	2.09	6.33	6.12	7.75	4.42

EXHIBIT II-14

IMPACT OF SELECTED SUBSIDIES ON THE ECONOMICS OF PRIVATELY OWNED RESOURCE RECOVERY PLANTS[1]

	Fuel Recovery		Materials Recovery		Pyrolysis		Incineration with Residue Recovery		Incineration with Steam Recovery		Incineration with Electricity Generation	
	Profit After Tax ($/ton of input)[2]	IRR[2]	Profit After Tax ($/ton of input)[2]	IRR[2]	Profit After Tax ($/ton of input)[2]	IRR[2]	Profit After Tax ($/ton of input)[2]	IRR[2]	Profit After Tax ($/ton of input)[2]	IRR[2]	Profit After Tax ($/ton of input)[2]	IRR[2]
No Subsidy	$2.13	13	$0.83	4	$0.44	3	$0.41	Negative	($0.56)	Negative	($3.57)	Negative
30% Cash Subsidy	$2.58	15	$1.50	6	$1.32	6	($0.07)	Negative	$0.22	2	($2.37)	Negative
$6/ton Cash Subsidy	$2.33	14	$1.67	8	$0.87	4	$0.00	Negative	($0.56)	Negative	($3.57)	Negative
75% Loan Interest Subsidy	$2.97	21	$2.24	14	$1.88	12	$0.90	10	$1.03	11	$0.21	7
25% Investment Tax Credit[3]	$2.77	17	$1.83	8	$1.54	6	$0.72	1	$0.72	3	($0.47)	Negative
5-Year Accelerated Depreciation[4]	$2.56	16	$1.50	6	$1.20	4	$0.53	0	$0.40	1	($1.50)	Negative

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[1] 1000 TPD plants with a 20 year life.

[2] $8/ton dumping fee assumed. IRR is the internal rate of return, the rate at which the present value of cash in-flow equals the present value of cash out-flow.

[3] This subsidy affects profit after tax in the year of the investment, but the subsidy impact has been shown as an equivalent annuity for illustrative purposes. It is also assumed that the plant either makes sufficient profit to allow taking the credit, or that the owner has other profitable businesses.

[4] This subsidy does not actually change plant profitability except in terms of the time value of money. (Cash flow is greater in early years, less in later years.) The time value impact has been shown as an equivalent annuity for illustrative purposes. This also assumes that the plant either makes a sufficient profit to allow taking the credit or that the owner has other profitable businesses.

Source: EPA calculations based on data from: Midwest Research Institute, Resource Recovery: The State of Technology, Washington, U.S. Government Printing Office, Feb. 1973.

Resource Recovery Plant Potential

The potential for resource recovery plant construction was determined by defining the maximum potential population base which could logically be served by such plants. There are a number of options for defining the maximum population base which recovery plants might serve. Using the total U.S. population is not reasonable because waste in rural areas in not likely to find its way to an urban recovery plant. A more logical base would be Standard Metropolitan Statistical Areas, but the political problems of bringing together numerous jurisdictional areas make this base larger than the practical potential. Cities were the base which we chose to use in this study since they represent population concentrations with the potential for building recovery plants. The cities which could support a 1000 ton per day plant and which now use or are highly likely to use incineration (or some other waste disposal method other than land fill) were identified as the specific base for defining the potential. It was felt that cost of resource recovery was far more comparable to disposal costs in these cities than in those with the option of land fill. Exhibit II-15 shows the population base used to define the potential.

Predicting the number of plants which will be built by 1985 in the absence of a subsidy is difficult because of the uncertainties of cost and technological feasibility associated with most of the recovery systems. Signficant indications of municipal interest in these plants has only come about in the last couple of years. The baseline estimate for plant construction was derived by EPA from their contacts with cities across the nation and was based on a city by city analysis of resource recovery plant interest. The estimate was that by 1985 the equivalent of 35 plants of 1000 ton per day capacity would be built.

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MAXIMUM POTENTIAL IMPACT FOR SUBSIDIES TO RESOURCE RECOVERY PLANTS

	1970	1975	1980	1985
US Population[1] (000)	203,212	216,553	232,966	251,271
Per Capita Solid Waste Generation (lbs./day)[2]	4	4.64	5.38	6.23
Population Required to support a 1000 TPD Plant	500,000	431,034	371,747	321,027
Number of Cities with population to support a 1000 TPD Plant[3]	26	32	41	51
Population served by Incineration in 1000 TPD Plants[4] (000)	9,398	10,364	15,935	23,619
Tons of Solid Waste served by Incineration per year (000)	6,861	8,776	15,646	26,854

[1] Based on a growth rate of 1.25% per year; Series C projections by the U.S. Department of Commerce, Bureau of the Census

[2] Based on a 3% per year increase in per capita solid waste generation

[3] Population in central cities is assumed to grown at a rate of 1% per year

[4] EPA estimates based on the following percentages, 30%, 30%, 38%, 41% for 1970, 1975, 1980, and 1985 respectively which assume a 5% per yar increase in population served by incineration from 1975 through 1985.

Source: EPA Estimates based on data from U.S. Department of Commerce, Bureau of the Census.

Prediction of Subsidy Impact

The prediction of subsidy impact is based on cost changes brought about by the subsidies. This prediction technique is limited, however, because cost is only one of many factors which weigh upon the decision to build a resource recovery plant. Risk, political implications, public attitudes and pressures and other factors are also very important in the decision process. Since there is no reasonable way of quantifying these factors, the prediction was made based on comparative plant economics.

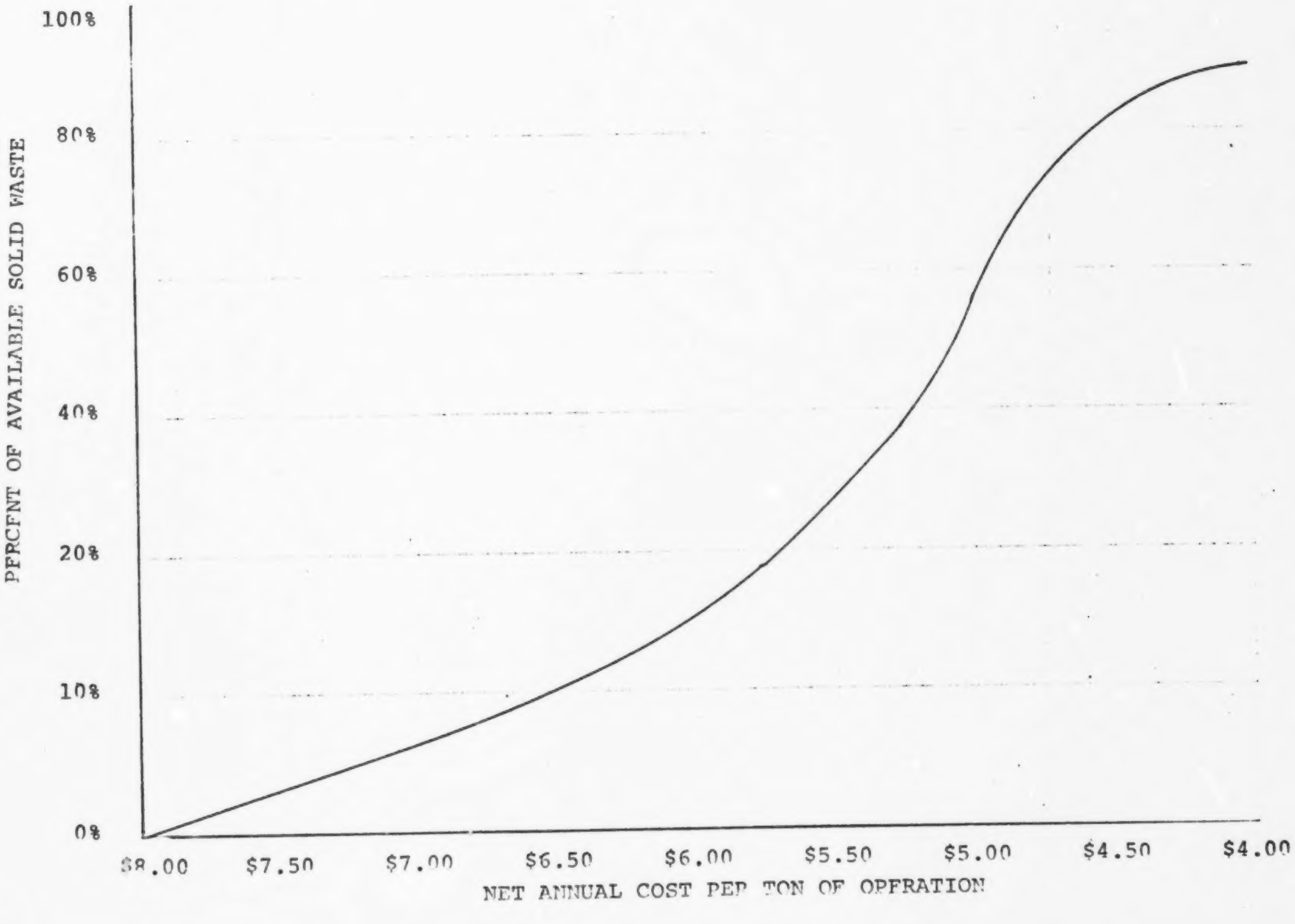
The graph or "decision curve" used to make the prediction is illustrated in Exhibit II-16 . This curve was constructed to relate the average cost per ton of the resource recovery plants to the number of municipalities that would build some form of plant. Developed through discussions with EPA, the graph represents a best estimate of the municipal decision to build a resource recovery plant based on a general knowledge of current alternative disposal means and costs.

The vertical axis of the graph is a percentage scale and indicates what percentage of the tons of solid waste available to be recovered through resource recovery will be recovered through municipally owned plants given various subsidies and their impact on the net annual cost per ton of operation. Exhibit II-17 gives the numerical results used in later calculations. The total available solid waste is assumed to be the tons of solid waste predicted to be served through incineration, or the tons which would be served through any disposal method other than close-in landfill. The graph uses cost per ton as the horizontal axis and the deciding factor as to what percentage of the total available solid waste will be processed through resource recovery systems given different costs per ton. The cost per ton figures used were average costs per ton of the six plants taken as a composite.

The decision curve itself was developed to reflect a number of factors and forms the classic "S" shaped curve typical of this type of analysis. The extent of present activity in resource recovery by cities and states and EPA's projections of this activity in the future provided a benchmark to judge the relative level of municipal

EXHIBIT II-16

MUNICIPAL DECISION CURVE



interest for the "no-subsidy" case. While this approach allows a straight-forward estimate of plant construction, the results must be considered "ballpark" figures since it is almost impossible to quantify and predict the exact nature of municipal decisions of this type.

The results of the prediction appear in Exhibit II-17 which shows the percentages of the total solid waste available to be processed and the number of plants constructed under the "no-subsidy" case and the six subsidy cases as well as the amount of materials and energy recovered through the projected plants. It should be noted here that no explicit consideration is taken of any learning curve effect for those plants which are built in the later years.

In order to predict the amounts of materials and energy to be recovered through the projected plants the six models were assumed to be combined in one composite type plant with average percentages of the various outputs. The combination of the six plants leads to the following percentages of the total tons processed going to the various materials and energy. The different kinds of energy recovery systems were analyzed in terms of BTU's per ton of solid waste processed.

RECOVERY RATES FOR COMPOSITE PLANT

Paper	2.5%
Glass	2.8%
Ferrous Metals (both before and after incineration)	4.1%
Non-Ferrous Metal	0.2%
Energy (6.8 x 10^{12}BTU's per 1.8 million tons processed)	

The paper fraction recovered appears small considering its high (37 percent) proportional representation in the waste stream due to the fact that only one of the recovery systems studied had any paper recovery and that the figures are on a dry weight basis. The ferrous fraction recovered is relatively significant because four of the six systems retrieve this resource in some form or

EXHIBIT II-17

RESULTS FROM DECISION CURVE

Subsidy	Percent*	No. of Plants Built		
		1975	1980 (Cumulative)	1985
No Subsidy	38.7	11	20	35
30% of Sales	73	21	38	65
$6/Ton Sold	51	15	27	47
25% C.G.	58	17	30	52
50% C.G.	76	22	40	68
75% C.G.	89	26	46	80
75% Credit	62	18	32	55

*These percentages indicate the percentage of the total available solid waste which will be processed through municipally-owned resource recovery plants.

other. Again it should be recognized that these recovery rates relect a composite of six plants not a representation of the potential of recovery of any of these outputs from any one plant.

Results of Analysis

The results of the application of the prediction methodology just described are presented in Exhibit II-18 which follows. Additional data, breaking the results down by year are presented in Appendix E.

There are some observations which should be made concerning the results presented in the following exhibit.

The pattern of recycling brought about by these subsidies is very different from that resulting from demand (user) subsidies. Energy recovery predominates over materials recovery because resource recovery plant technology is heavily weighted toward energy recovery at the present time.

Windfall is high, ranging from 44 to 71 percent. This results from the EPA prediction that roughly 35 plants would be built by 1985 without a subsidy.

Comparison of the various subsidies is difficult because they are not equivalent level subsidies. Were all of the subsidies made equivalent, the incremental recycling induced and the incremental cost per ton for all of the subsidies would be roughly the same. A choice between subsidies would have to be made on the basis of other criteria, such as the mix of plant types encouraged by the different subsidies. A $6 per ton subsidy, for example, would apply only to material output, and would therefore tend to encourage plants which emphasize materials rather than energy recovery.

It should again be emphasized that these are "ballpark" predictions. The difficulty in understanding and quantifying the municipal decision-making process as well as the still uncertain economics of the plants make high confidence predictions almost impossible.

EXHIBIT II-18

SUMMARY RESULTS OF SUBSIDY TO MUNICIPAL RESOURCE RECOVERY PLANTS

		30% of Sales	$6 per Ton Sold	Construction Grant (% Federal Share)			75% Credit
				25%	50%	75%	
Note 1	Incremental Resource Recovery						
	Paper (000 tons)	1,500	593	850	1,660	2,215	1,059
	Cans (000 tons)	2,460	970	1,390	2,718	3,633	1,650
	Glass (000 tons)	1,678	665	948	1,846	2,475	1,125
	Energy (10^{12} BTUs)	221	90	128	256	334	152
Note 2	Total Cost to Federal Government ($000,000)	70	52	128	334	590	232
Note 3	Incremental Cost ($/ton)	4.96	3.67	2.13	5.57	9.83	8.69
Note 4	Incremental Increase in Resource Recovery (%)	88	35	50	97	130	62
Note 5	Windfall (%)	53	74	67	52	44	64
Note 6	Incremental Number of Resource Recovery Plants	30	12	17	33	45	20

Notes to the Tables

Note 1. Incremental Resource Recovery

This is simply the result of the prediction methodology previously described. Incremental recycling is that from plants built over the baseline which is shown below.

Baseline

	(Total) 1976-1985	
Paper		1,705,000 tons
Cans		2,793,000 tons
Glass		1,905,000 tons
Energy		258×10^{12} BTU
Plants		35

Note 2. Total Cost to the Federal Government

The cost of the output subsidies (30% of Sales and $6 per ton) equal the total sales of the plant times the amount of the subsidy. In the case of the per-ton subsidy ($6 per ton) energy sales are excluded. The cost of the construction grants equals the Federal share of capital costs of the plants. The cost of the credit subsidy equals the 75% of the interest expense over the period 1975-2005.

Note 3. Cost Per Incremental Process Ton

Because both energy and materials are recovered, the incremental cost is calculated using total processed tonnage rather than output. Thus, the figures are most important from a relative standpoint and should not be compared with the user subsidy analysis. The cost per ton equals Total Cost to Federal Government divided by the total tonnage processed through resource recovery systems. For the credit subsidy, the total tonnage processed includes only the total amount over the ten year period of the subsidy.

Note 4. Incremental Increase in Resource Recovery

This figure equals the percentage increase in recovery over the baseline.

Note 5. Windfalls

The windfall is calculated by dividing the cost of subsidizing the baseline by the total cost of the resource recovery plants subsidies.

Note 6. Incremental Number of Resource Recovery Plants

One measure of the success of a subsidy is the number of resource recovery plants that would be built as a result of its application. The number of plants listed represents composite 1000 ton per day plants.

APPENDIX A

USER COST MODELS

Introduction

The following discussion is intended to provide the reader with a brief background on each user industry and to present the user cost models used in the analysis.

Paper and Paperboard

Exhibit A-1 presents the flow of materials and products in the paper industry. An old saying illustrating one of the major factors affecting recycling in this industry is "paper is not paper is not paper." The production process starts with two basic types of roundwood (softwood and hardwood); processes them into approximately eight major grades of pulp (sulphite, sulphate, dissolving, soda, semi-chemical, groundwood, defibrated, screenings); manufactures these into eleven basic grades of paper and paperboard (newsprint, printing and writing, packaging, tissue, unbleached kraft, solid bleached, semi-chemical, combination); which are converted and combined into a myriad of products. The mechanics of reclassifying these products into a raw material form that is compatible with one or more of the basic processes are not simple.

The percentage of total wastepaper (including PCW) as a fibrous input has declined from 36.6 percent in 1944 to 19.8 percent in 1971. The wastepaper recycled in 1971 (10.996 million tons) may be subdivided as follows:[4]

Grade	Percent of Recycled Paper
Mixed	29.6
News	18.9
Corrugated	31.9
High Grade Pulp Subs.	12.5
High Grade Deinking	4.5

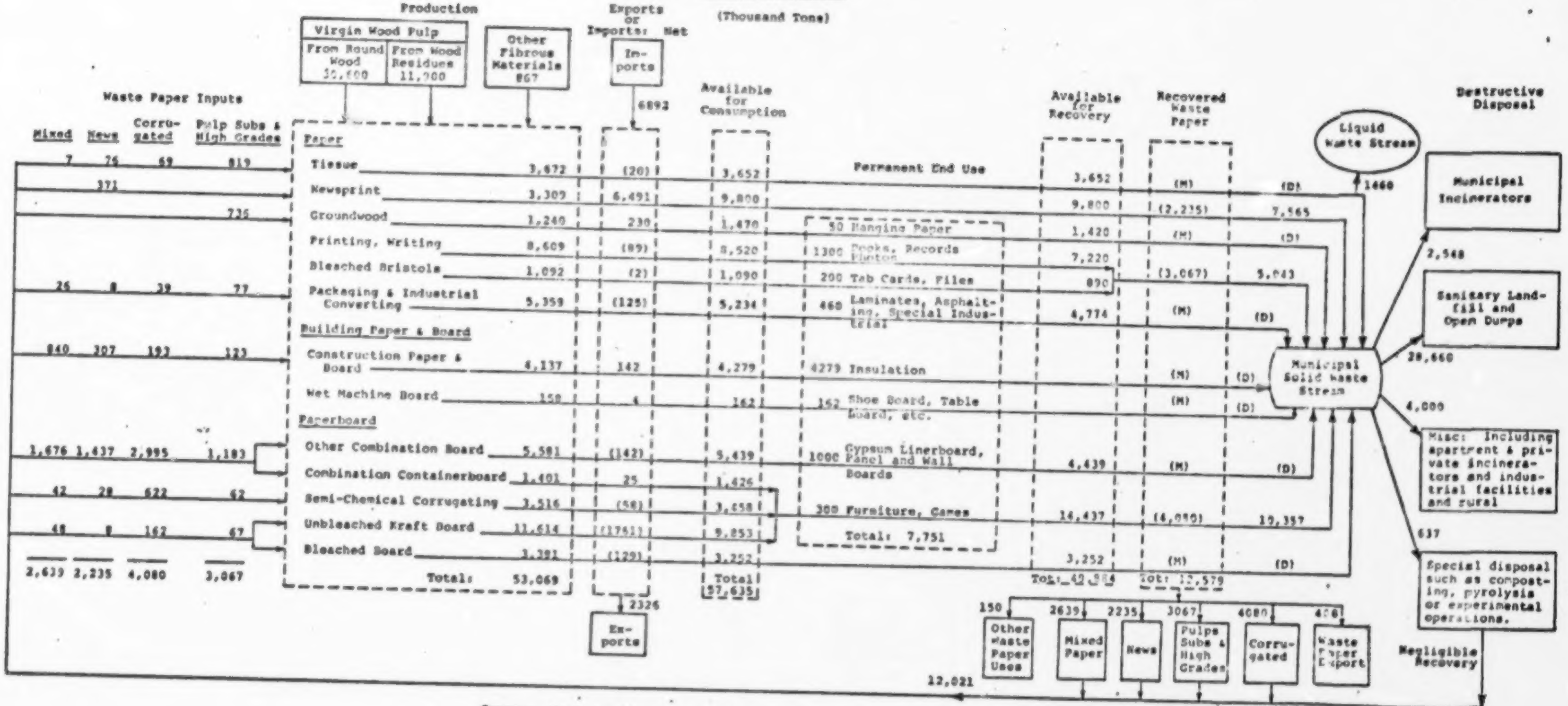
There are a number of factors that have acted to limit and reduce the amount of post consumer waste used in this industry:

1. Level of Integration - Integrated mills account for the major part of the total output -- the twenty largest account for 70 percent, the 50 largest for 90 percent. This has resulted in a production orientation

EXHIBIT A-1

PAPER, PAPERBOARD, CONSTRUCTION PAPER AND BOARD AND WASTE PAPER FLOWS, UNITED STATES - 1970

(Thousand Tons)


Production
Virgin Wood Pulp
From Round Wood 30,600
From Wood Residues 11,900
Other Fibrous Materials 867
Exports or Imports: Net
Im-ports
6892
Available for Consumption
Waste Paper Inputs
Mixed
News
Corru-gated
Pulp Subs & High Grades
7 76 69 819
371
736
26 8 39 77
840 307 193 123
1,676 1,437 2,995 1,183
42 28 622 62
48 8 162 67
2,639 2,235 4,080 3,067
Paper
Tissue 3,672 (20) 3,652
Newsprint 3,309 6,491 9,800
Groundwood 1,240 230 1,470
Printing, Writing 8,609 (89) 8,520
Bleached Bristols 1,092 (2) 1,090
Packaging & Industrial Converting 5,359 (125) 5,234
Building Paper & Board
Construction Paper & Board 4,137 142 4,279
Wet Machine Board 158 4 162
Paperboard
Other Combination Board 5,581 (142) 5,439
Combination Containerboard 1,401 25 1,426
Semi-Chemical Corrugating 3,516 (58) 3,458
Unbleached Kraft Board 11,614 (1761) 9,853
Bleached Board 3,381 (129) 3,252
Total: 53,069
Total 57,635
2326
Ex-ports
Permanent End Use
50 Hanging Paper
1300 Books, Records Photos
200 Tab Cards, Files
460 Laminates, Asphalting, Special Industrial
4279 Insulation
162 Shoe Board, Table Board, etc.
1000 Gypsum Linerboard, Panel and Wall Boards
300 Furniture, Games
Total: 7,751
Available for Recovery
3,652
9,800
1,420
7,220
890
4,774
4,439
14,437
3,252
Tot: 49,884
Recovered Waste Paper
(M)
(2,235)
(M)
(3,067)
(M)
(M)
(M)
(M)
(4,050)
(M)
Tot: 12,579
(D)
7,565
(D)
5,043
(D)
(D)
(D)
(D)
10,357
(D)
Liquid Waste Stream
1460
Municipal Solid Waste Stream
Destructive Disposal
Municipal Incinerators
2,548
Sanitary Land-fill and Open Dumps
28,660
4,000
Misc: Including apartment & private incinerators and industrial facilities and rural
637
Special disposal such as composting, pyrolysis or experimental operations.
Negligible Recovery
150
Other Waste Paper Uses
2639
Mixed Paper
2235
News
3067
Pulps Subs & High Grades
4080
Corru-gated
408
Waste Paper Export
12,021

Source: Resource Planning Associates, Inc.
American Paper Institute

Notes: "D" - Volumes to waste stream are unknown.
"M" - Recovery as mixed papers, volumes unknown.

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with a high degree of concern for the predictability of raw material supplies thus limiting the interest in waste paper.

2. The supply of paper waste and the practicability of recycling varies regionally (urban area sources of waste stock vs. rural area sources of virgin fiber).

3. The market demand for products made of secondary fibers is decreasing. This trend has resulted from economies of scale possible with virgin mills, the specification set by the commercial packager or user (not the final consumer) and the adverse economics of paper stock mills versus wood pulp mills.

To examine the possibilities of post consumer waste use in more depth, five segments of the industry that use PCW were reviewed for structural, technical, economic, and attitudinal factors affecting PCW use. These industry segments (linerboard, corrugating medium, and folding boxboard in the paperboard industry; news and tissue in the paper industry) represent the largest relatively homogeneous sectors which could technologically use secondary fiber input.

Linerboard

In 1971 linerboard accounted for 43.4 percent of all paperboard production and 21.5 percent of the output of the domestic paper industry. For the past 17 years, production has exceeded the average growth of the paperboard industry (6.5 percent versus 3.8 percent) and it is estimated that this growth will continue well into the 1980's.

Linerboard production is concentrated in the South Atlantic and East South Central states. Most production of the unbleached Kraft linerboard (98 percent of all linerboard production) usually occurs in large integrated mills. The average capacity of the 40 mills producing Kraft linerboard is approximately 800 tons per day.

In contrast to virgin linerboard, combination linerboard has taken a progressively smaller share of the market declining from 11.6 percent in 1961 to 2.3 percent in 1971. Industry observers attribute most of this decline to three factors: improved economics of the new, large scale integrated Southern and Western paper mills; the higher quality and strength of the virgin-based Kraft linerboard; and consumer preference for virgin-based products.

Much investment is in new, large, and relatively efficient virgin mills. Increased use of PCW will therefore most likely result either from new plants as increased capacity is required, or possibly from incremental furnish to some of the large, integrated mills.

The economics of a new mill designed to use only PCW in the production of combination linerboard are shown in Exhibit A-2. The projected mill will have the capacity to produce 375 tons of combination linerboard per day (135,000 tons per year) from 100 percent waste paper, primarily old corrugated containers. The mill is assumed to be located near sources of waste paper. Investment required is approximatly $18 million.

The selling price of the linerboard is $119/ton F.O.B. mill. It is assumed that the customer pays an additional $4/ton freight charge, bringing the price of the realized combination linerboard to approximately $123. The American Paper Institute indicates that this price would be competitive with the price for virgin linerboard at approximately $139 per ton.

Corrugating Medium

Virgin corrugating medium, usually Neutral Sulfite Semi-Chemical with some chemical or waste added, has increased in market share over bogus medium over the past ten years (from about 72 percent in 1960 to 81 percent in 1970).

Medium production is not nearly as integrated as linerboard production. In general, the mills are smaller, not geographically concentrated, and correspond more with population distribution than linerboard mills making them very accessible to waste paper.

The semi-chemical process (neutral sulfite) converts hardwood pulpwood into a special high-yield pulp used largely for corrugating medium. The average mill has a capacity of 250 tons per day and there are approximately

EXHIBIT A-2

LINERBOARD MILL INCOME/COST MODEL

	Annual ($000)	Per Output Ton ($)
Revenues		
Sales of Combination Linerboard (135,000 tons @ $123)	16,065	119.00
TOTAL REVENUE	16,065	119.00
Expenses		
PCW Input Cost *	4,500	33.33
Operating Cost	8,100	60.00
Depreciation (16 yrs. straight line)	1,125	8.33
Interest (@ 9%)	1,620	12.00
TOTAL EXPENSES	15,345	113.67
PROFIT BEFORE TAX (per year)	720	5.33

*-50/50 mix of old corrugated containers @ $32 per ton and prompt at $42 per ton.

Source: American Paper Institute (This information was culled from a number of studies supported by the API and updated from discussions with Institute personnel.)

40 semi-chemical pulp mills and 35 semi-chemical corrugating medium mills. In 1971 about 714 thousand tons of waste paper, mostly old corrugated boxes, were used in the production of corrugating medium. Corrugating medium made from combination furnish now holds about 19 percent of the market.

Corrugating medium is a growing sector of the paperboard industry. The production of semi-chemical medium has grown at the rate of 6.4% annually over the last 17 years. This sector of the paper industry offers substantial opportunities to increase demand for PCW.

In the semi-chemical production old and converting corrugated constitute over 82 percent of the waste paper/board used. In combination board production in general about 44 percent was corrugated, 24 percent mixed, 18 percent news and 14 percent pulp substitutes and high grades.

Observations which can be made about further use of PCW in corrugating medium include the following:

First, extensive commercial use of combination medium already exists on a nearly comparable basis with virgin medium.

Second, medium production is not nearly as integrated as linerboard production. The mills tend to be smaller, not geographically concentrated, and more in line with population distribution than linerboard.

Third, like linerboard, corrugating medium is a growth sector of the paperboard industry, indicating substantial opportunities to increase the number of PCW based mills as capacity additions are made.

The projected mill is designed to produce 9-point corrugating medium using 100 percent waste paper (seventy percent PCW). The mill has an output capacity of 300 tons per day (105,000 tons per year) and is assumed to be located near the customers and sources of secondary fiber (primarily old corrugated containers) of a large Midwestern city. Investment required for a new mill in 1972 was approximately $18.6 million. (See Exhibit A-3)

EXHIBIT A-3

CORRUGATING MEDIUM INCOME/COST MODEL

	Annual ($000)	Per Ton ($)
Revenues		
Sales of corrugated medium (105,000 tons @ $123.00)	12,915	123.00
Expenses		
Wastepaper raw materials**		
PCW wastepaper (81,200 tons @ $32)	2,598	24.74
Prompt wastepaper (34,800 tons @ $42)	1,462	13.90
Operating	4,020	38.29
Depreciation (16 year-straight line)	1,163	11.08
Interest (@ 9%)	1,674	15.94
TOTAL EXPENSES	10,917	103.97
PROFIT BEFORE TAX	1,998	19.03

**116,000 tons total, principally old corrugated containers. Industry source estimates 70 percent obsolete, 30 percent prompt. Freight at $5.00 per ton average is included in the wastepaper prices.

Source: RPA estimates from confidential industry source.

Folding Boxboard

Folding boxboard made from virgin fiber has increased its market share from 24 percent to 39 percent between 1960 and 1970. In the same period, market share of combination boxboard has declined from 76 percent to 61 percent. Indications are that this trend will continue.

Folding boxboard is a relatively low growth segment of the paperboard industry, showing only a 2.1 percent increase in total output, from 3,375,000 tons in 1961 to 4,090,000 tons in 1971.

A number of factors have contributed to the decline in market share of combination folding boxboard. Chief among these is its adverse technical performance relative to virgin material. Also, there has been an increased sensitivity to potential adverse health effects in food packaging made from contaminated PCW (PCB problem). A shift to plastic and novelty containers by former users of combination folding boxboard has also contributed to the decline.

Economically, combination boxboard can compete adequately with the virgin material; however, the marketing factors mentioned above appear to be a significant constraint.

In 1972, a new combination boxboard mill producing "newsback" grade board of a caliper of .020 inches would have had the following economic and performance characteristics.

The mill would produce 300 tons per day (105,000 tons per year). It is assumed to be located near a major city where wastepaper could be delivered at a transportation cost of $6/ton. Investment required for a new mill is approximately $25,000,000. (See Exhibit A-4)

Newsprint

Domestic newsprint production is concentrated in the Southern region of the U.S., with over 54 percent of 1971 capacity located in the 16 states of this region. The area with the next highest concentration is the mountain Pacific region, with over 25 percent of the total capacity.

EXHIBIT A-4

FOLDING BOXBOARD INCOME/COST MODEL

	Annual ($000)	Per Ton ($)
Revenues		
Sales of newsback (105,000 tons @ $165.00)	17,300	165.00
Expenses		
Wastepaper		
PCW wastepaper @ $27	2,500	23.80
Prompt wastepaper @ $40	1,264	12.03
Operating Costs (including labor, chemicals, S, G&A, and all other costs)	8,460	80.57
Depreciation (16 yrs., straight line)	1,560	14.85
Interest (@ 9%)	2,250	21.42
TOTAL EXPENSES	16,034	152.67
Profit before tax	1,266	12.33

Source: RPA estimates based on data from Midwest Research Institute study, "Resource Recovery - The State of Technology".

Exhibit A-1 points out that in 1971, approximately 68 percent of domestically-used newsprint was imported. Over 97 percent of these imports came from Canada.

Most U.S. newsprint production takes place in 25 mills with capacities ranging from 300 to 500 tons per day. About 2 million tons of the newsprint consumed in the U.S. comes from mills that are owned or controlled by American newspaper publishing companies.

It is now possible to de-ink old newspapers and reconstitute the fibers into new newsprint. To date, only one domestic producer, The Garden State Paper Company, has made extensive use of the technique. Yearly its three facilities process 350,000 tons of the approximately three and one half million tons of newsprint produced in this country. Other companies have recently announced plans to implement the process.

In the short run, at least, markets are "locked in". Publishers own their sources of supplies and provide 20 percent of domestic consumption. Much of the virgin mill capacity in the South is new and large. However, since consumption is growing at 5 percent annually, opportunities exist for installing PCW mills to satisfy new capacity needs.

Our newsprint mill is located near a large urban area that can provide both sources of waste news and customers for newsprint. (See Exhibit A-5)

The mill will use 100 percent old news as the fiber raw material. The plant requires $24 million investment. This facility can accept baled old news, de-ink it, and produce new newsprint as a final product.

Tissue

Tissue production in the United States is heaviest in the two adjacent regions of the Mid-Atlantic and East North Central States, with over 50 percent produced here. The low cost of the product and its light weight make it advantageous to locate mills close to the areas of highest population density.

Tissue production has grown at the rate of 5.1 percent annually over the past 17 years and now stands at 3,697 thousand tons (1971).

EXHIBIT A-5

NEWSPRINT INCOME/COST MODEL

	Annual ($000)	Per Ton ($)
Revenues		
Sales of newsprint (110,000 tons @ $150)	16,500	150.00
Expenses		
Wastepaper raw materials*		
PCW News (107,900 tons @ $35.08)	3,785	34.41
Prompt news (22,100 tons @ $35.08)	775	7.05
Other materials and direct costs	7,206	65.50
Selling, General $ Administrative	385	3.50
Depreciation (16 years, straight line)	1,500	13.64
Interest (@ 9%)	2,160	19.64
TOTAL EXPENSES	15,811	143.74
PROFIT BEFORE TAX	689	6.26

*RPA estimates 130,000 tons old news total will be divided into 83% obsolete, 17% prompt. Freight at $5.08 per ton average is included.

Source: The figures come from a confidential, knowledgable industry source.

EXHIBIT A-6

PCW TISSUE MILL INCOME/COST MODEL

	Annual ($000)	Per Ton ($)
Revenues		
Sales of tissue pulp (17,375 tons @ $156)	2,711	156.03
Expenses		
Ledger wastepaper (22,890 tons @ 76% yield)	1,877	108.03
Chemicals	131	7.52
Labor and Service	285	16.40
Utilities and Waste Treatment	256	14.75
Depreciation (16 yrs., straight line)	153	8.81
Interest (@ 9%)	207	11.91
TOTAL EXPENSES	2,909	167.42
PROFIT (LOSS) BEFORE TAX	(198)*	(11.40)*

*The loss reflects a mismatch between the price of waste paper which generally was not controlled as closely as the price of tissue pulp in 1972. Since the evaluation of the impact of the subsidies is in relative terms, absolute profit or loss was not that significant.

Source: Confidential Industry Source.

There are approximately 100 mills producing tissue in the U.S., and although some mill capacity may reach over 600 tons per day, the average mill produces between 100 and 110 tons per day.

In 1971 about 1,054 thousand tons of waste paper were used in tissue production. About 90% of this (884 thousand tons) came from pulp substitutes and high grade waste paper such as uncoated milk carton overruns, stampings from cup stock base, and other conversion plant waste paper. These high grades need almost no processing and are simply repulped and screened. In certain tissues, it is possible to use waste papers of lower quality, such as old newsprint and containers.

Geographically, tissue producers generally are in good locations to receive PCW. Also, there are no major technical problems in using PCW in tissue products. The limitation is in getting an adequate supply of a specific quality. Product performance as well as health considerations cause many tissue manufacturers to shy away from PCW.

A new tissue pulp mill produces 17,375 tons of pulp made from 100 percent PCW ledger wastepaper. The selling price for tissue pulp is based on the market price of the virgin pulp replaced. Investment required is $2,300,000. (See Exhibit A-6.)

Steel Industry

A recent study by the EPA staff has identified five potential markets for post-consumer cans. In all but the copper precipitation industry, little experience exists with the use of these cans. In most cases, there are some technological problems and substantial logistical problems working to limit recycling.

The analysis focused on two of the more promising alternatives, the use of post-consumer cans as part of the scrap charge to electric furnaces and as inputs to the detinning industry. Exhibit A-7 presents the overall flow of materials in the industry.

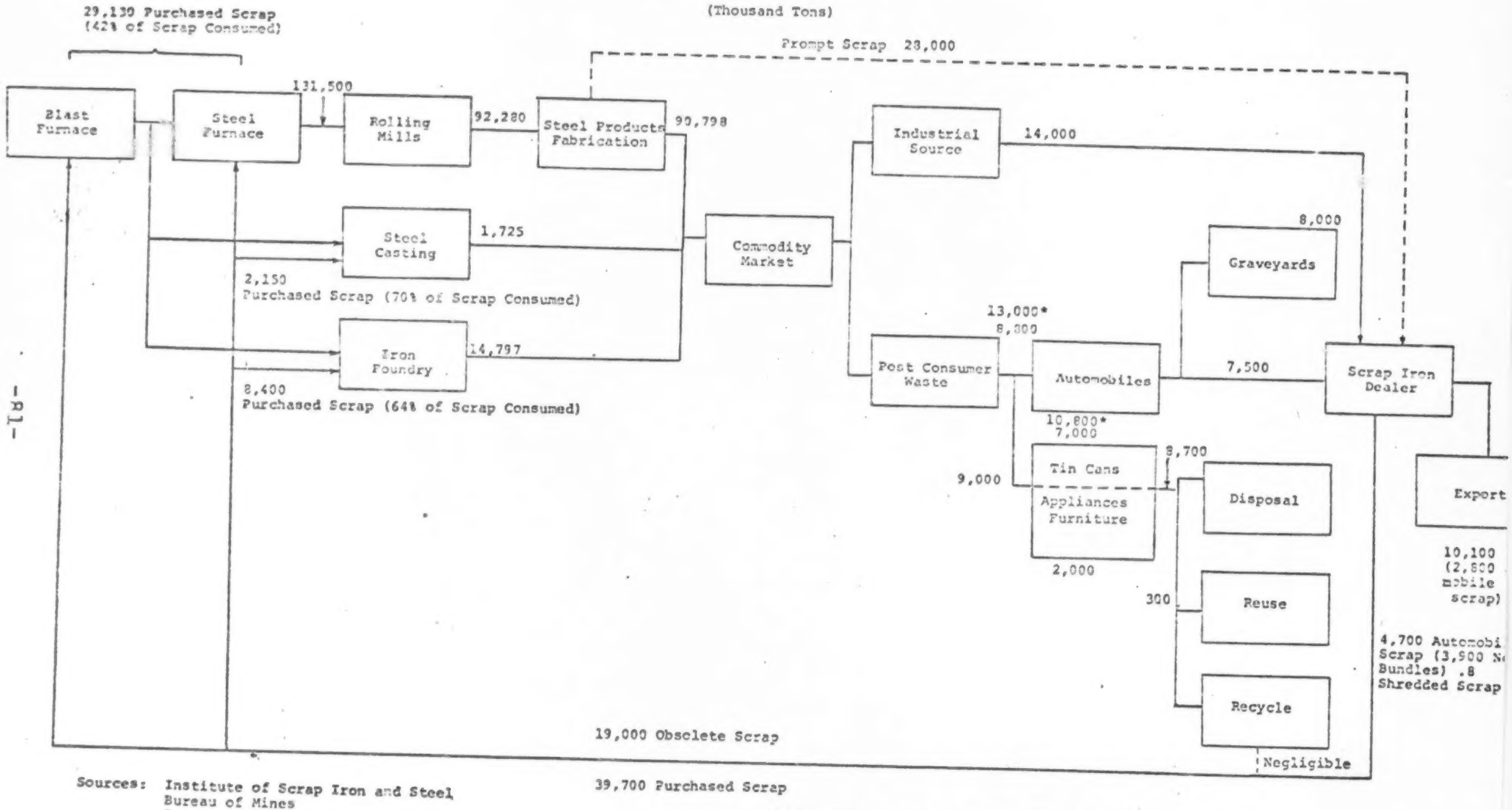
Mini-Mills

Mini-mills typically using electric arc-type furnaces

EXHIBIT A-7

1970 IRON AND STEEL INDUSTRY

(Thousand Tons)


29,130 Purchased Scrap
(42% of Scrap Consumed)
Prompt Scrap 28,000
Blast Furnace
Steel Furnace
131,500
Rolling Mills
92,280
Steel Products Fabrication
90,798
Steel Casting
1,725
2,150
Purchased Scrap (70% of Scrap Consumed)
Iron Foundry
14,797
8,400
Purchased Scrap (64% of Scrap Consumed)
Commodity Market
Industrial Source
14,000
Post Consumer Waste
13,000*
8,800
Automobiles
10,800*
7,000
Graveyards
8,000
7,500
Tin Cans
Appliances
Furniture
9,000
2,000
8,700
Disposal
300
Reuse
Recycle
Negligible
Scrap Iron Dealer
Export
10,100
(2,800
mobile
scrap)
4,700 Automobi
Scrap (3,900 N
Bundles) .8
Shredded Scrap
19,000 Obsolete Scrap
39,700 Purchased Scrap

Sources: Institute of Scrap Iron and Steel
Bureau of Mines
Resource Planning Associates

*1980 Forecast of domestic iron and steel consumption and obsolete scrap generation.

have capacities usually ranging between 10 and 35 tons per heat with total time cycle averaging about five hours.

Mini-mills operate in a supply-sales radius of 200 to 300 miles. In the 20 years since their establishment, about 45 mills have been built with total annual capacity of over 6 million tons of carbon steel products.

Mini-mills currently have the capacity for using over 6 million tons annually of ferrous scrap. However, almost all of the scrap now used comes from industrial sources or auto shredders within a 300 mile radius of the mill. This scrap typically includes #1 and #2 heavy melting, #1 and #2 bundles, shredded scrap, turnings, and #1 bushelings. There has been virtually no use of undetinned steel cans from municipal refuse.

The principal constraint associated with undetinned cans is the potential problems caused by tin and lead. Lead tends to migrate to the bottom of a melt and damage furnace linings, and tin, which is soluble in steel, decreases product ductility and leads to cracking and tearing during forming operations. It has been estimated that a 5% charge of undetinned can scrap could be used in the production of reinforcing bars (low quality steel).

The economics of a hypothetical mill using PCW are shown in Exhibit A-8. The proposed mill would use an electric furnace to produce 100,000 tons per year of rebars or structurals from 135,400 input tons of scrap. The required investment for such a mill would be $10 million. Such a mill would include the following equipment and facilities: an electric furnace, a billet continuous caster, a billet reheat furnace, a rolling mill, in-process storage, a warehouse, and laboratories.

Detinners

The detinning industry consists of five companies with processing operations in fourteen locations. The two largest, M & T Chemical and Vulcan Materials, are approximately the same size and represent over 90 percent of the industry's sales. M & T, a subsidiary of the American Can Company since 1961, has six plants located in Maryland, Indiana, New Jersey, Washington, California

EXHIBIT A-8

MINI-MILL INCOME/COST MODEL

	Annual ($000)	Per Ton ($)
Revenues		
Sales of rebar (100,000 tons @ $130)	13,000	130.00
Expenses		
Raw Materials (Total)	4,856	48.86
Incinerator bundles (10,400 tons @ $14)	146	1.46
Detinned cans (30,000 tons @ $35)	1,050	10.50
Auto scrap (70,000 tons @ $38)	2,660	26.60
Home and other purchased scrap (25,000 tons @ $40)	1,000	10.00
Non-classified processing costs (@ $7/output ton)	4,700	47.00
Selling, General & Administrative (8.5% of sales)	1,100	11.00
Depreciation (20 yr., straight line)	500	5.00
Interest (@ 9%)	900	9.00
TOTAL EXPENSES	12,056	120.56
PROFIT BEFORE TAX	944	9.44

Source: RPA estimate from discussions with Florida Steel Corporation.

and Florida. M & T processes about 350,000 gross tons of tinplate scrap yearly. Other detinners have plants in Pennsylvania, Wisconsin, California and New Jersey.

Detinning has not grown substantially since 1960. Tonnage of tinplate processed in 1960 and 1971 equalled 700,000 and 752,000 gross tons, respectively. Tin recovery has dropped from 3,275 to 2,369 gross tons over the same period because of the thinner coatings of tin on cans and the introduction of tin-free steel cans with durable lacquers replacing the tin. Currently, most detinning facilities are operating below capacity.[1]

Currently almost all tinplate scrap comes from industrial sources. In 1972 only 3000 gross tons of tin cans were processed by M & T, yielding 6 pounds per ton of reclaimed tin.

The detinned steel scrap, when baled, is a high grade material for producing new steel products. When shredded, it provides a clean, uniform and reactive ingredient for reclaiming copper by the precipitation process. It sells at or near the price for #1 bundles.

There are several factors which inhibit the use of post consumer cans in the detinning industry. As noted above, the majority of raw materials into the detinning plant were prompt can scrap; only 3,000 tons of post consumer cans were processed in 1971. The factors which inhibit greater use are outlined below.

- Presence of aluminum: Aluminum in the municipal can fraction adversely affects the production process. The caustic detinning solutions preferentially attack the aluminum, resulting in large quantities of processing chemicals being used.

- Physical form: Cans for detinning must be clean and have a high area to weight ratio. Thus, the cans cannot be baled or balled during shredding and must be cleaned prior to detinning.

- Non-incinerated: Incinerated post consumer cans cannot be detinned.

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[1] Steel Can Study - R.R. Div. U.S. EPA, June 1973.

EXHIBIT A-9

DETINNING PLANT INCOME/COST MODEL

	Annual ($000)	Per Ton ($)
Revenues		
Sales of #1 bundles (30,000 tons @ $30)	900	29.88
Sales of Tin (225,000 pounds @ $1.75)	394	13.08
Total Revenues	1,294	42.96
Expenses		
Raw Materials		
Metal cans (30,113 tons @ $20)*	602	20.00
Processing Costs (labor, caustic soda, fuel)	300	9.96
Depreciation (15 years, avg.)	100	3.32
Interest (@ 9%)	135	4.48
TOTAL EXPENSES	1,137	37.76
PROFIT BEFORE TAX	157	5.20

*The $20/ton price for cans assumed a 1.5 percent aluminum content. If there were a .75 percent aluminum content, the detinner would be willing to pay $25/ton. If the cans have a 3 percent aluminum content (tops and bottoms) then the detinner would pay only $10-15/ton because his processing costs would rise between $5 and $10.

Source: RPA estimate based on confidential industry sources.

For an example of the economics of detinning, we worked with a detinner to estimate the costs of a new hypothetical plant using PCW cans. As yet, no such plant has been built. (See Exhibit A-9.)

The projected detinning plant buys 30,113 tons of cans per year, separates the tin from the steel, and sells 30,000 tons of steel and 225,000 pounds of tin. Investment required is $1,500,000.

Glass

Glass manufacturing is divided into three components: container, flat and pressed/blown. Container glass accounts for about 73 percent of total industry production, with flat and pressed/blown comprising the remaining 27 percent. In 1972 container manufacturers produced 11.6 million tons of glass. The container segment of the industry will be the focus of this analysis because it contributes the bulk of the glass flowing into the municipal waste stream.

Containers can be categorized into three main groups: 1) beverage (soft drink, beer, liquor and wine); 2) food; and 3) sundry (medicines, cosmetics, and chemicals). In 1972, 56.0 percent were for food and 12.9 percent for sundries. Ninety-five percent of beverage container shipments were one way bottles.

In the United States the glass container industry consists of 40 companies operating 120 plants. Between 1960 and 1970, glass container shipments increased 70 percent, from 157 to 267 million gross. Container shipments by weight increased 75 percent during the same period, from 6.5 to 11.3 million tons.

The future suggests an overall increase in production of glass containers. Between 1971 and 1975, for example, we can expect a rise of 11 percent in container manufacture, from 267 to 296 million gross. And between 1971 and 1980, we estimate a 32 percent increase over the decade, from 267 to 352 million gross.

Glass container manufacture is a fully integrated process in that basic raw materials are converted to finished products at one location. Silica sand is combined with soda ash, burnt lime or limestone, and other materials. The industry, historically, has looked to plant cullet as a vital component in the manufacturing process.

Cullet,with a lower melting temperature than the mixture of virgin raw materials,tends to reduce overall energy needs. The temperature decrease also results in an extended furnace life.

Experience with municipal cullet has varied widely. Recently some manufacturers have developed techniques for increasing the ratio of cullet to other raw materials. For example, one company has manufactured containers using a mix of 15 percent in-house cullet and 85 percent external cullet for a period of one week with good results. This test batch was limited in time due to the lack of a dependable supply of external cullet.

While the glass industry recycled approximately 250,000 tons of PCW glass in 1972, any plan to increase the recycling of glass would require a means of developing a consistent supply source. Unlike paper (with established brokers or dealers) or ferrous (with magnetic separation), at this time PCW glass can only be recycled through source separation because of the lack of any automatic color sorting.

The postulated plant uses 100 percent cullet to produce new glass containers. Plant output is 200 gross tons per day, with 15 percent generated as scrap cullet, for a net yield of 170 tons per day, or 62,050 tons per year. Investment required is $7,745,000. (See Exhibit A-10.)

EXHIBIT A-10

GLASS BOTTLE PLANT INCOME/COST MODEL

	Total (15% Home Cullet) (85% PCW Cullet) ($000)	Per Ton ($)
Revenues		
Sales of glass containers (62,050 tons @ $140)	8,687	140.00
Expenses		
Raw Materials		
Home cullet (10,950 tons @ $00)	0	0
PCW cullet (62,050 tons @ $20)	1,241	20.00
Fuel	243	3.92
Labor through furnace	110	1.77
Other labor	1,533	24.70
Selling, General & Other Overhead	2,993	48.24
Depreciation	861	13.88
Interest (@ 9%)	643	10.36
TOTAL EXPENSES	7,624	122.87
PROFIT BEFORE TAX	1,063	17.13

Source: Confidential Industry Source.

APPENDIX B

EXAMPLE OF THE APPLICATION OF USER METHODOLOGY

This appendix serves as an example of the procedure for evaluating subsidies, in this case, to the newsprint segment of the paper industry. The example is presented to provide the reader with a more concrete idea of the procedure used to evaluate each subsidy applied to each industry segment. The example illustrates the shapes of the curves and provides a summary of the factors considered in their development. Exhibit B-1 is presented here as a roadmap to the analysis.

The procedure followed yields as a final result the incremental amount of PCW-based capacity that will be added in a given year. Five pieces of data are needed to perform the calculation.

1.	Internal Rate of Return (IRR) with Subsidy	
2.	Investment Profile Curve	Exhibit B-2
3.	Supply/Price Risk Curve	Exhibit B-3
4.	Experience Curve	Exhibit B-4
5.	Maximum Potential Impact Curve	Exhibit B-5

Calculation

Step 1 - Apply Subsidy to Cost Model

This calculation shows that the new IRR with subsidy would equal 35%.

Step 2 - Apply IRR to the Investment Profile Curve.

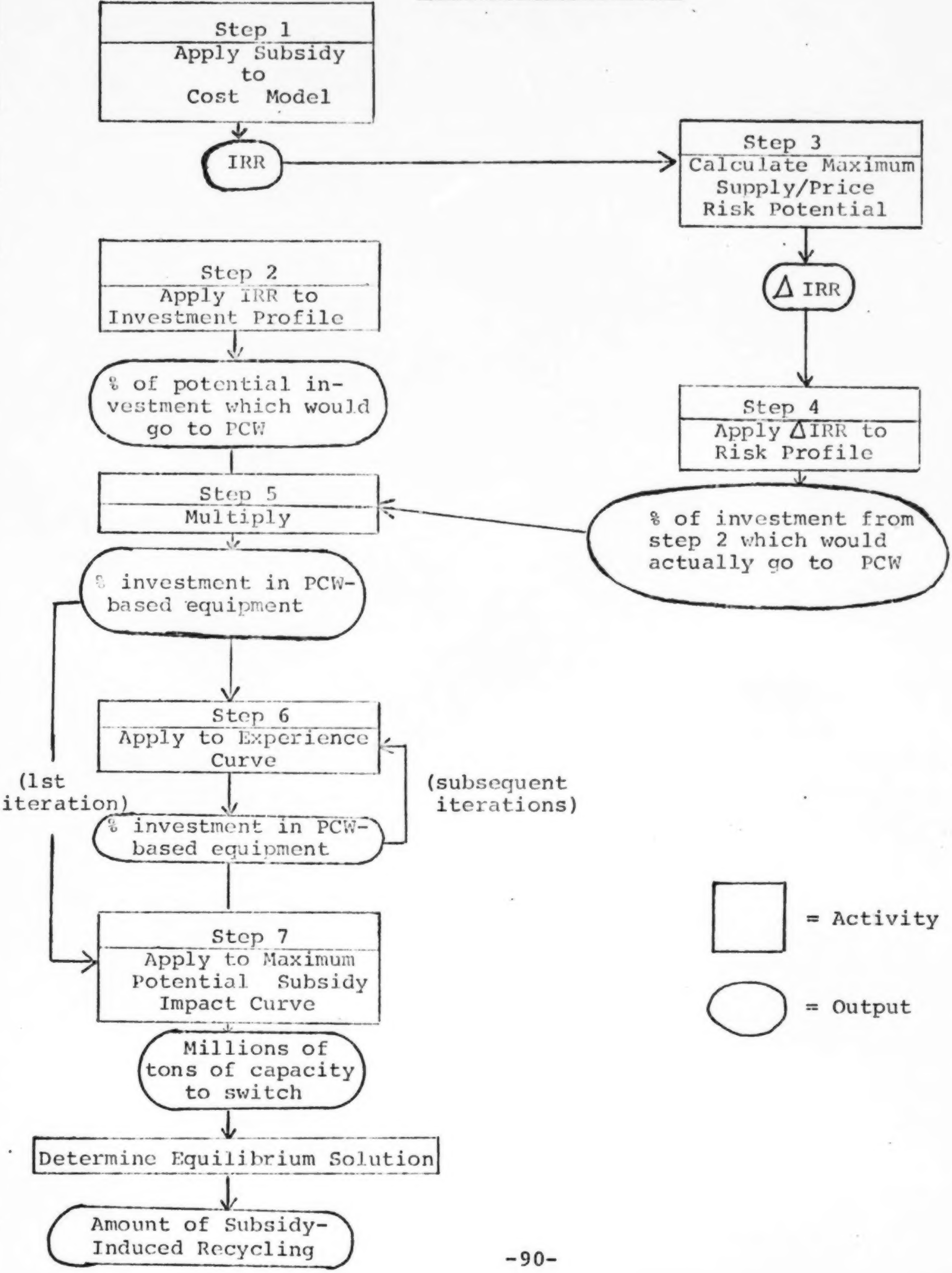
Entering the curve at 35% IRR indicates that 27.5% of capacity needs would be met by PCW-based plant investments.

Step 3 - Calculate Maximum Supply/Price Risk Potential.

The calculation represents the % change in IRR that would result if the price of the subsidized PCW rises 25%. In the case of our newsprint plant model, the IRR would drop to 28%. The Risk Potential then is calculated as follows:

EXHIBIT B-1

USER IMPACT ANALYSIS


Step 1
Apply Subsidy to Cost Model
IRR
Step 3
Calculate Maximum Supply/Price Risk Potential
Δ IRR
Step 2
Apply IRR to Investment Profile
% of potential investment which would go to PCW
Step 4
Apply ΔIRR to Risk Profile
Step 5
Multiply
% of investment from step 2 which would actually go to PCW
% investment in PCW-based equipment
Step 6
Apply to Experience Curve
(1st iteration)
(subsequent iterations)
% investment in PCW-based equipment
Step 7
Apply to Maximum Potential Subsidy Impact Curve
Millions of tons of capacity to switch
Determine Equilibrium Solution
Amount of Subsidy-Induced Recycling
= Activity
= Output

$$\frac{35\% - 28\%}{35\%} = 20\% \text{ IRR change}$$

Step 4 - Calculate Supply/Price Sensitivity.

Entering the Supply/Price Risk Curve at 20% yields a 68% figure. This figure means that, given the price/supply risks associated with use of secondary material inputs to production, 68% of capacity needs would be met by PCW-based plant investments.

Step 5 - Multiply Step 3 by Step 4.

The result from Step 3 is multiplied by the result from Step 4 to yield (68% times 27.5%) 18.6%. Therefore, given the general business risks and price/supply risk, 18.6% of users with capacity needs would choose PCW based investment.

Step 6 - Apply Experience Curve.

Entering the curve at 18.6% experience level, the result is an experience factor of 1.38. Therefore from 1975-1980 due to experience gained previously, 38% more capacity need will be met by PCW-based capacity than in the pre-1975 period. To calculate the 1980-1985 percentage for PCW-based capacity, enter the curve at 25.6% experience level (18.6 x 1.38).

Step 7 - Apply Capacity % to Maximum Potential Subsidy Impact

The maximum potential impact (the vertical distance between production requirements and effective capacity) on the curve is 1.5 million tons. Thus, considering growth in the industry and rate of obsolescence of capacity, 1.5 million tons of new capacity will have to be added in 1975. Of this capacity, 25.6% (from Step 6) will be PCW-based. Therefore, 385,000 tons of PCW-based capacity would be induced by the subsidy.

EXHIBIT B-2

NEWSPRINT GENERAL BUSINESS RISK CURVE

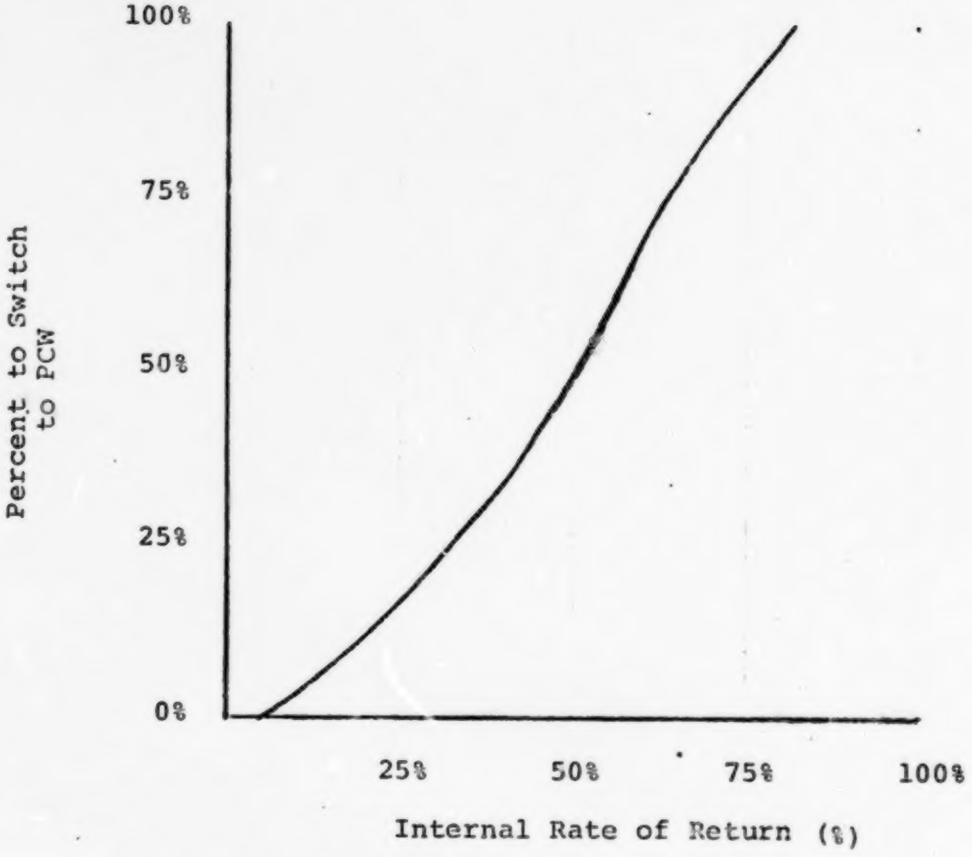


EXHIBIT B-3

PRICE/SUPPLY RISK PROFILE

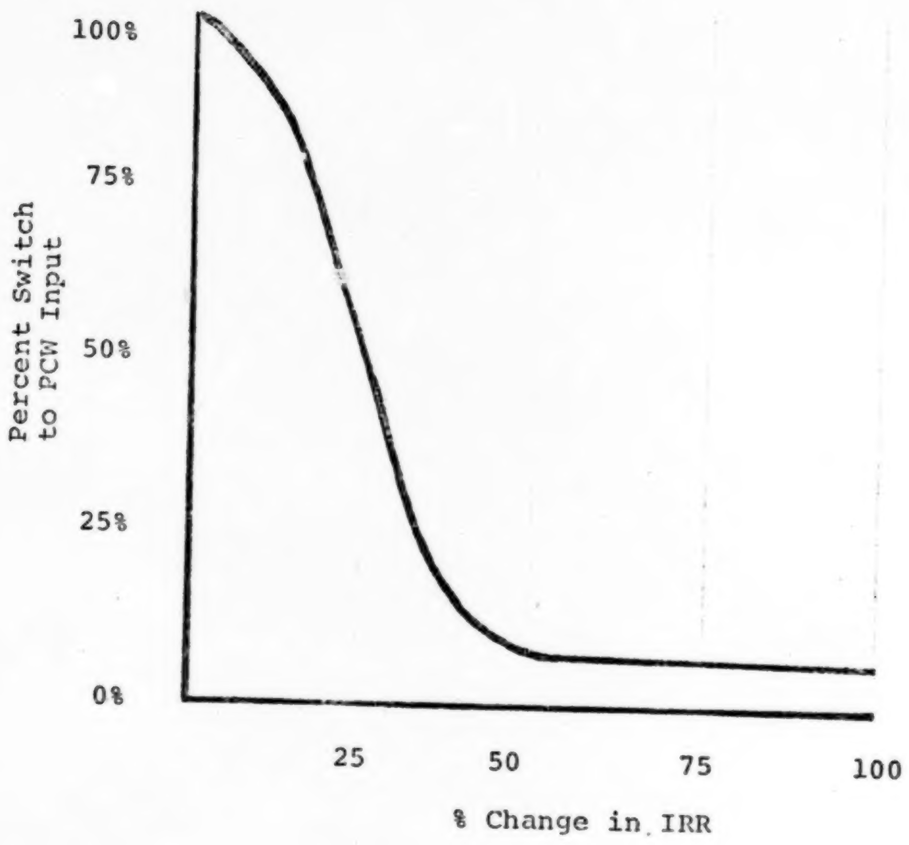


EXHIBIT B-4

NEWSPRINT EXPERIENCE CURVE

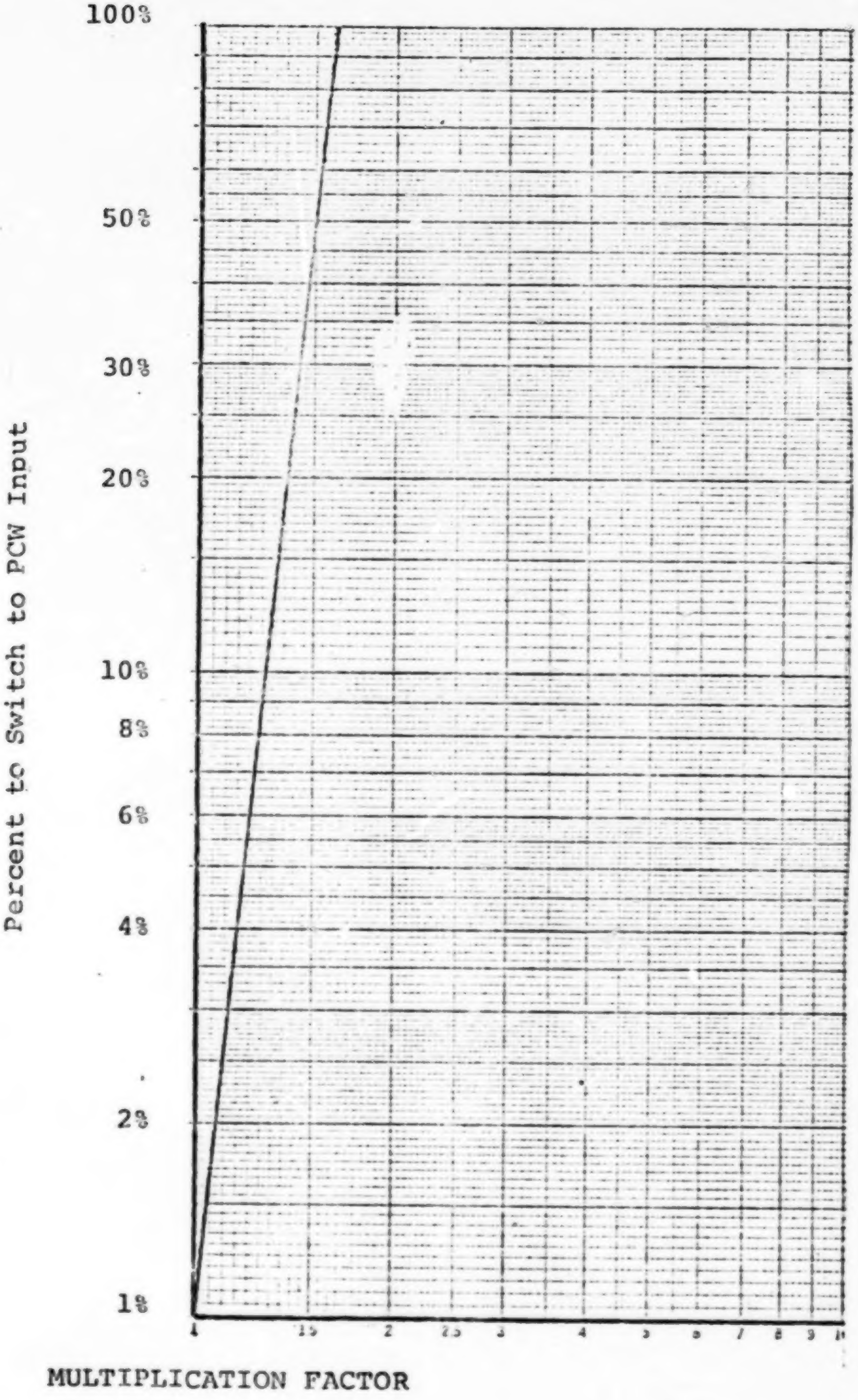
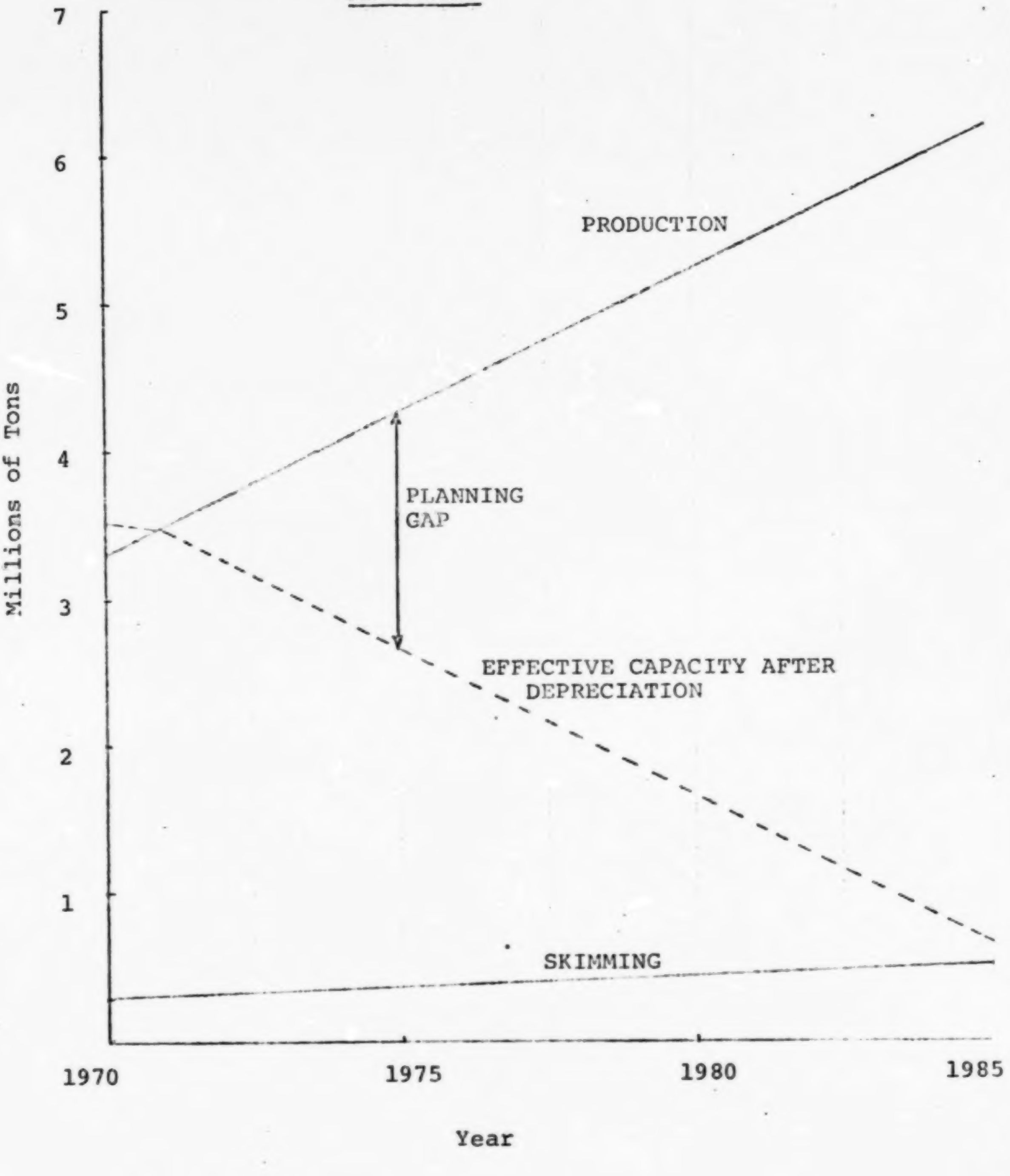


EXHIBIT B-5

MAXIMUM POTENTIAL IMPACT CURVE
NEWSPRINT



APPENDIX C

DETAILED RESULTS OF USER SUBSIDY ANALYSIS

EXHIBIT C-1

POST CONSUMER WASTE USE

30 PERCENT OF PURCHASE PRICE SUBSIDY

	YEAR	BASELINE SKIMMING (000 TONS)	BASELINE RESOURCE RECOVERY PLANT OUTPUT (000 TONS)	TOTAL BASELINE INDUSTRY PCW USE (000 TONS)	IMPACT OF SUBSIDY: NEW INVESTMENT (000 TONS)	IMPACT OF SUBSIDY: USE OF PCW IN VIRGIN BASED PLANTS (000 TONS)	TOTAL INDUSTRY PCW USE (000TONS)
PAPER	1975	8258	82	8340	1130	252	9722
	1980	9509	151	9660	3607	540	13807
	1985	10957	263	11220	5895	840	17955
CANS	1975	86	135	221	262	NA	483
	1980	116	246	362	567	NA	929
	1985	210	431	641	754	NA	1395
GLASS CONTAINERS	1975	261	92	353	53	NA	406
	1980	333	168	501	157	NA	658
	1985	425	294	719	248	NA	967

EXHIBIT C-2

INCREMENTAL INDUSTRIAL USAGE OF POST CONSUMER WASTE

SUBSIDY: 30% CASH

	PAPER (000 tons)	CANS (000 tons)	GLASS (000 tons)
1976	1935	323	74
1977	2488	384	95
1978	3041	445	115
1979	3594	506	136
1980	4147	567	157
1981	4665	604	175
1982	5182	642	193
1983	5700	679	212
1984	6217	717	230
1985	6735	754	248
10 YEAR TOTAL	43705	5620	1635

EXHIBIT C-3

SUBSIDY COST AND EFFECTIVENESS

30 PERCENT OF PURCHASE PRICE SUBSIDY

	COST TO GOVERNMENT ($000) 1976-1985	PERCENT WINDFALL % Avg.	INCREMENTAL RECYCLING (000 TONS) 1976-1985	COST PER TON $ Avg.
PAPER	1,289,365	74.42	43,705	29.50
CANS	47,319	42.63	5,620	8.42
GLASS	42,018	76.65	1,635	25.70
TOTAL	1,388,702			

EXHIBIT C-4

POST CONSUMER WASTE USE

$6 PER TON OF INPUT SUBSIDY

	YEAR	BASELINE SKIMMING (000 TONS)	BASELINE RESOURCE RECOVERY PLANT OUTPUT (000 TONS)	TOTAL BASELINE INDUSTRY PCW USE (000 TONS)	IMPACT OF SUBSIDY: NEW INVESTMENT (000 TONS)	IMPACT OF SUBSIDY: USE OF PCW IN VIRGIN BASED PLANTS (000 TONS)	TOTAL INDUSTRY PCW USE (000TONS)
PAPER	1975	8258	82	8340	599	117	9056
	1980	9509	151	9660	1899	265	11824
	1985	10957	263	11220	3101	419	14740
CANS	1975	86	135	221	407	NA	628
	1980	116	246	362	872	NA	1234
	1985	210	431	641	1194	NA	1835
GLASS CONTAINERS	1975	261	92	353	28	NA	381
	1980	333	168	501	83	NA	584
	1985	425	294	719	130	NA	849

EXHIBIT C-5

INCREMENTAL INDUSTRIAL USAGE OF POST CONSUMER WASTE

SUBSIDY: $6/TON CASH

	PAPER (000 tons)	CANS (000 tons)	GLASS (000 tons)
1976	1006	500	39
1977	1295	593	50
1978	1585	686	61
1979	1874	779	72
1980	2164	872	82
1981	2435	936	92
1982	2706	1001	102
1983	2978	1065	111
1984	3249	1130	121
1985	3520	1194	130
10 YEAR TOTAL	22812	8756	861

EXHIBIT C-6

SUBSIDY COST AND EFFECTIVENESS

$6 PER TON OF INPUT

	COST TO GOVERNMENT ($000) 1976-1985	PERCENT WINDFALL % Avg.	INCREMENTAL RECYCLING (000 TONS) 1976-1985	COST PER TON $ Avg.
PAPER	728,712	81.32	22,812	31.94
CANS	77,586	32.27	8,756	8.86
GLASS	37,374	86.18	861	43.41
TOTAL	843,672	76.94		

EXHIBIT C-7

POST CONSUMER WASTE USE

25 PERCENT INVESTMENT TAX CREDIT SUBSIDY

	YEAR	BASELINE SKIMMING (000 TONS)	BASELINE RESOURCE RECOVERY PLANT OUTPUT (000 TONS)	TOTAL BASELINE INDUSTRY PCW USE (000 TONS)	IMPACT OF SUBSIDY: NEW INVESTMENT (000 TONS)	IMPACT OF SUBSIDY: USE OF PCW IN VIRGIN BASED PLANTS (000 TONS)	TOTAL INDUSTRY PCW USE (000TONS)
PAPER	1975	8258	82	8340	603	117	9060
	1980	9509	151	9660	1935	265	11860
	1985	10957	263	11220	3156	419	14795
CANS	1975	86	135	221	353	NA	574
	1980	116	246	362	689	NA	1051
	1985	210	431	641	955	NA	1596
GLASS CONTAINERS	1975	261	92	353	60	NA	413
	1980	333	168	501	190	NA	691
	1985	425	294	719	302	NA	1021

EXHIBIT C-8

INCREMENTAL INDUSTRIAL USAGE OF POST CONSUMER WASTE

SUBSIDY: 25% INVESTMENT TAX CREDIT

	PAPER (000 tons)	CANS (000 tons)	GLASS (000 tons)
1976	1016	420	86
1977	1312	487	112
1978	1608	555	138
1979	1904	622	164
1980	2200	689	190
1981	2475	742	212
1982	2750	795	235
1983	3025	849	257
1984	3300	902	280
1985	3575	955	302
10 YEAR TOTAL	23165	1016	1976

EXHIBIT C-9

SUBSIDY COST AND EFFECTIVENESS

25 PERCENT INVESTMENT TAX CREDIT SUBSIDY

	COST TO GOVERNMENT ($000) 1976-1985	PERCENT WINDFALL % Avg.	INCREMENTAL RECYCLING (000 TONS) 1976-1985	COST PER TON $ Avg.
PAPER	304,795	61.0	23,165	13.16
CANS	22,826	30.55	7,016	3.25
GLASS	19,238	54.79	1,976	9.74
TOTAL	346,859			

EXHIBIT C-10

POST CONSUMER WASTE USE

75 PERCENT CREDIT SUBSIDY

	YEAR	BASELINE SKIMMING (000 TONS)	BASELINE RESOURCE RECOVERY PLANT OUTPUT (000 TONS)	TOTAL BASELINE INDUSTRY PCW USE (000 TONS)	IMPACT OF SUBSIDY: NEW INVESTMENT (000 TONS)	IMPACT OF SUBSIDY: USE OF PCW IN VIRGIN BASED PLANTS (000 TONS)	TOTAL INDUSTRY PCW USE (000TONS)
PAPER	1975	8258	82	8340	770	161	9271
	1980	9509	151	9660	2430	355	12445
	1985	10957	263	11220	3973	560	15753
CANS	1975	86	135	221	313	NA	534
	1980	116	246	362	653	NA	1015
	1985	210	431	641	913	NA	1554
GLASS CONTAINERS	1975	261	92	353	36	NA	389
	1980	333	168	501	93	NA	594
	1985	425	294	719	146	NA	865

EXHIBIT C-11

INCREMENTAL INDUSTRIAL USAGE OF POST CONSUMER WASTE

SUBSIDY: 75% USER CREDIT SUBSIDY

	PAPER (000 tons)	CANS (000 tons)	GLASS (000 tons)
1976	1302	381	47
1977	1673	449	59
1978	2043	517	70
1979	2414	585	82
1980	2785	653	93
1981	3135	705	104
1982	3484	757	114
1983	3834	809	125
1984	4183	861	135
1985	4533	913	146
10 YEAR TOTAL	29386	6630	975

EXHIBIT C-12

SUBSIDY COST AND EFFECTIVENESS

75 PERCENT CREDIT SUBSIDY

	COST TO GOVERNMENT ($000) 1976-1985	PERCENT WINDFALL % Avg.	INCREMENTAL RECYCLING (000 TONS) 1976-1985	COST PER TON $ Avg.
PAPER	734,526	68.29	29,386	18.65
CANS	45,383	34.51	6,630	6.85
GLASS	31,735	76.11	975	32.55
TOTAL	811,644	76.11		

EXHIBIT C-13

POST CONSUMER WASTE USE

5 YEAR ACCELERATED DEPRECIATION SUBSIDY

	YEAR	BASELINE SKIMMING (000 TONS)	BASELINE RESOURCE RECOVERY PLANT OUTPUT (000 TONS)	TOTAL BASELINE INDUSTRY PCW USE (000 TONS)	IMPACT OF SUBSIDY: NEW INVESTMENT (000 TONS)	IMPACT OF SUBSIDY: USE OF PCW IN VIRGIN BASED PLANTS (000 TONS)	TOTAL INDUSTRY PCW USE (000TONS)
PAPER	1975	8258	82	8340	323	30	8693
	1980	9509	151	9660	1015	113	10788
	1985	10957	263	11220	1648	186	13045
CANS	1975	86	135	221	193	NA	414
	1980	116	246	362	378	NA	740
	1985	210	431	641	542	NA	1183
GLASS CONTAINERS	1975	261	92	353	17	NA	370
	1980	333	168	501	50	NA	551
	1985	425	294	719	78	NA	797

EXHIBIT C-14

INCREMENTAL INDUSTRIAL USAGE OF POST CONSUMER WASTE

SUBSIDY: 5-YEAR ACCELERATED DEPRECIATION

	PAPER (000 tons)	CANS (000 tons)	GLASS (000 tons)
1976	508	230	24
1977	663	267	30
1978	818	304	37
1979	973	341	43
1980	1128	378	50
1981	1269	411	56
1982	1410	444	61
1983	1552	476	67
1984	1693	509	72
1985	1834	542	78
10 YEAR TOTAL	11848	3902	518

EXHIBIT C-15

SUBSIDY COST AND EFFECTIVENESS

5 YEAR ACCELERATED DEPRECIATION SUBSIDY

	COST TO GOVERNMENT ($000) 1976-1985	PERCENT WINDFALL % Avg.	INCREMENTAL RECYCLING (000 TONS) 1976-1985	COST PER TON $ Avg.
PAPER	95,010	79.19	11,848	8.02
CANS	6,953	43.66	3,902	1.78
GLASS	230	82.43	518	0.44
TOTAL	102,193	76.78		

APPENDIX D

DESCRIPTION OF RESOURCE RECOVERY PLANTS

Introduction

This section contains a brief description of the six resource recovery systems chosen for analysis. The dollar figures on investment requirements, operating costs, and resource recovery revenues are all extracted from the U.S. Government document entitled "Resource Recovery, the State of Technology", published in February, 1973. Trends in the last few years indicate that many of these investment figures are low, in some cases substantially so. In addition, while cost projections often include revenues from the sale of such recovered materials as glass and non-ferrous metals, no full-scale operational systems have yet demonstrated their ability to recover these materials from mixed municipal solid waste.

The results, then, must be viewed as most accurate only from a relative standpoint. The six resources recovery systems evaluated include:

1. Mechanical Processing into Saleable Raw Materials (Black Clawson System)
2. Incineration with Residue Recovery (Bureau of Mines System)
3. Fuel Recovery for Utility Boilers (St. Louis Model)
4. Incineration with Waste Heat Recovery
5. Combustion with Direct Conversion of Gases into Electricity (CPU-400 Model)
6. Pyrolysis

Mechanical Processing

This plant is based mainly on the concept developed by the Black-Clawson Company in their Hydrasposal/Fibreclaim system currently in operation in a pilot project in Franklin, Ohio. This system is a complete recovery and disposal process using mixed municipal waste as an input. The heart of the system is the hydropulper in which all pulpable, grindable, and friable materials such as food

EXHIBIT D - 1

MECHANICAL SEPARATION

(1,000 tons per day plant)

Total Investment Required: $11,568,000

Amortized:[1]	$1,368,000
Fixed:[2]	9,570,000
Recoverable:[3]	630,000

		Cost per Ton of Input
Annual Costs		
Operating	1,320,000	
Fixed	182,000	
Capital Charges[4]	1,257,000	
Total	2,759,000	9.20
Annual Revenues		
Sale of Recovered Resources		
Ferrous	245,000	
Nonferrous	240,000	
Glass	158,000	
Paper	675,000	
Total	1,328,00	4.43
Net Annual Cost of Operation:	1,431,000	4.77

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[1] Engineering costs, R & D expenditures, starting costs.

[2] Plant and equipment.

[3] Land, working capital.

[4] Debt services.

waste, paper, plastics and rubber, rags, glass, wood, leaves, etc., are disintegrated and removed through an internal screen as a water slurry. After a series of separation steps the longer paper fibers are recovered and short fibers and other organic materials are burned. Steel is magnetically separated while the glass and aluminum portions are recovered through optical sorting.

Unless they are upgraded in some way the paper fibers recovered from this system will most likely have a limited market due to the fact that they are considered to be a much lower grade than any fibers recovered by preseparation of solid waste. Only certain grades of paper and board can use these fibers in the paper-making processes unless they are upgraded. Black-Clawson has designed a variation of this system which burns all of the organic fraction to produce steam rather than recovering paper fibers.

The income statement for the model plant indicates the sensitivity of plant economics to the sale and market prices of the recovered materials and, therefore, the relatively significant impact of a $6/ton or 30 percent of sales subsidy on the economics of the system. For instance, if the value of the recovered resource were to be half of that expected, the net annual cost of operation would increase by 47 percent. If neither the paper fibers nor the ferrous fraction could be sold at all, the cost would increase by 64 percent even without considering the increased cost of residue disposal.

Incineration With Residue Recovery

This plant uses as a model the United States Bureau of Mines design for recovering non-ferrous and ferrous metals, glass, and certain ash components after incineration. Procedures such as shredding, screening, grinding and magnetic separation are employed to recover the saleable products -- steel, aluminum, and glass.

These materials are assumed to be marketable although the glass aggregate is more suitable for use in special products such as bricks, glass wood, or road surfacing than in glass-making. The incineration process creates an inter-metallic bond between tin and iron which precludes tin reclamation and limits the market

EXHIBIT D - 2

INCINERATION WITH RESIDUE RECOVERY

(1,000 ton per day plant)

Total Investment Required:	$10,676,000	
Amortized:	1,277,000	
Fixed:	8,760,000	
Recoverable:	639,000	
Annual Costs		Cost per Input Ton
Operating	1,355,000	
Fixed	175,000	
Capital Charges	1,159,000	
Total	2,689,000	$8.96
Annual Revenues		
Sales of Recovered Resources		
Ferrous	127,000	
Nonferrous	240,000	
Glass	168,000	
Total	535,000	$1.78
Net Annual Cost of Operation:	$2,154,000	$7.18

potential of the ferrous fraction of the residue.

When considered as a total system (incinerator and recovery unit), this plant requires a capital investment of $10,676,000 or about $35.60 per yearly input ton. The residue recovery unit accounts for about $1.3 million of the total investment. The economics of the system as a whole are not highly sensitive to the revenues derived from the residue recovery operations; therefore, a materials output subsidy would not have a major impact on operating cost per ton. It should be noted, however, that the recovery unit can be installed on existing incinerators and its economics would be quite different. However, there are a very limited number of existing incinerators which would be candidates for the residue recovery unit because many existing incinerators do not meet air pollution regulations.

Recovery for Supplemental Fuel

This plant is based primarily on the prototype plant in St. Louis pioneered by Horner-Shifrin, Inc. where milled solid waste is burned by Union Electric Company as a supplemental fuel in their tangentially-fired suspension power burning plant furnances. In this system, raw municipal waste is first shredded and air classified and ferrous metals are removed from the heavy fraction and then the light, heavily organic fraction is transported to the utility for use as a fuel.

Recovery for supplemental fuel has been successfully demonstrated and is perhaps the most promising of the six plant types. It has stimulated considerable interest by municipalities, utilities, and industry.

The attractively low capital investment of $7,577,000 or $25.26 per yearly input ton, means that even if revenues from the sale of the waste fuel are lower than expected the net cost of the system will be relatively low. However, the value of the waste fuel has a signficant impact on plant economics and can reduce net annual cost to very low levels. The low capital investment level is mainly due to the fact that only the

EXHIBIT D - 3

RECOVERY FOR SUPPLEMENTAL FUEL

(1,000 ton per day plant)

Total Investment Required:	$7,577,000	
Amortized:	877,000	
Fixed:	6,200,000	
Recoverable:	500,000	
Annual Costs		**Cost per Input Ton**
Operating	798,000	
Fixed	116,000	
Capital Charges	817,000	
Total	$1,731,000	$5.77
Annual Revenues		
Sale of Fuel	675,000	
Sale of Ferrous	245,000	
Total	$920,000	$3.07
Net Annual Cost of Operation:	$811,000	$2.70

waste processing system and not the waste burning system must be constructed since the system utilizes existing utility boilers. In the subsidy analysis the shredded waste was not judged as an output which would be eligible for a plant output subsidy based on a dollar-per ton, though it was assumed eligible for the percent of value output subsidy. A capital subsidy would have a relatively small impact on this system compared with the other five systems described here because of its low capital investment. (See Exhibit D - 3.)

Incineration With Steam Recovery

This plant is based on the general economics of heat recovery as steam either from a conventional incinerator or a high temperature slagging incinerator. Various methods for recovering energy as steam have been developed; however, the investment and the cost of operation for the range of types do not differ substantially.

Several municipalities have utilized convectional waste heat boilers installed in refractory wall incinerators for heat recovery. In Chicago, Miami, Boston, Providence and Hampstead, Long Island, such facilities are now in operation. Some of these municipalities have experienced difficulties or have been unable to market the steam.

Another technique for a steam recovery is in the waterwall incinerator. This system has worked successfully in Europe where the steam is fed to power stations. In the United States, both Braintree, Massachusetts and Chicago's Northwest Incinerator have waterwall systems; Saugus, Massachusetts and Nashville, Tennessee have similar systems under consideration.

It is important to note that because of the nature of steam distribution, any incinerator producing recovered steam must be located near its customers. This sometimes means substantially higher land costs for such a plant than for a conventional incinerator built on the outskirts of the city.

EXHIBIT D - 4

INCINERATION WITH STEAM RECOVERY

		Cost per Input Ton
Total Investment Required:	$11,607,000	
Amortized:	$1,414,000	
Fixed:	9,480,000	
Recoverable:	713,000	
Annual Costs		
Operating	1,654,000	
Fixed	199,000	
Capital Charges	1,263,000	
Total	3,116,000	$10.38
Annual Revenues		
Sale of Steam	1,000,000	$3.33
Net Annual Cost of Operation:	$2,116,000	$7.05

The investment required for this model is $11,607,000 or $38.70 per yearly input ton. The economics of this system are relatively closely tied to the revenues received from the sale of recovered steam. For example, the net annual cost per ton increases by 24 percent if sales drop by 50 percent; if there are no customers at all, the cost per ton increases by 42 percent to $10.38 per ton. A material output subsidy based on $6 per ton would not be applicable in this situation and the percentage of sales subsidy has only a small effect on the costs of operation. However, a capital subsidy would exert a major impact on the economics of an incinerator-steam recovery system. (See Exhibit D - 4).

Direct Conversion to Electricity

This plant is based entirely on the pilot CPU-400 plant developed in 1971 by Combustion Power Company in Menlo Park, California. This system includes a shredding and classifying stage which prepares the waste for feeding into a high pressure fluid bed combustor whose hot gases drive a gas turbine/generator to produce electricity. The shredding and classifying subsystem has been demonstrated; however, the performance of the entire system with its recent alterations has not been fully demonstrated.

Although the model used in this study does not include a materials recovery system, the complete CPU-400 unit would contain equipment for recovering the ferrous fraction, aluminum, and a mixed glass and rock fraction. At this time, there are no full-scale plants of this kind in operation, nor are there any known plans to build such a system.

The high investment requirement of $17,717,000 or $59 per yearly input ton capacity may limit the development and implementation of this energy recovery system. A capital subsidy would have a large impact on the economics of the system; a material output subsidy would have relatively little impact since the per-ton cash subsidy does not apply to BTU's of energy. Cost per ton for a 1000 tons per day plant is 34 percent higher than for a plant processing 250 tons per day indicating that this plant has significant economies of scale. (See Exhibit D - 5).

EXHIBIT D - 5

INCINERATION WITH ELECTRIC GENERATION

(1000 tons per day)

Total Investment Required:		$17,717,000	
Amortized	2,080,000		
Fixed	14,900,000		
Recoverable	737,000		
Annual Costs			Cost per Input Ton
Operating	1,748,000		
Fixed	212,000		
Capital Charges	1,932,000		
TOTAL	$3,892,000		$12.97
Annual Revenues			
Sale of Electricity	1,200,000		
TOTAL	$1,240,000		$ 4.00
Net Annual Cost of Operation	$2,692,000		$ 8.97

Pyrolysis

Various pyrolysis processes are currently in the pilot plant and testing stages. This plant uses Garrett Research and Development's system as a model. It produces fuel oil and recovers the ferrous, aluminum and glass portions of the waste for sale. A 150 ton per day demonstration plant, now operational in San Diego, California, indicates that by using flash pyrolysis, more than one barrel of oil can be produced from one ton of dry, organic material. Development of other forms of pyrolysis to produce various products such as methane gas, methanol, acetone oil and a pure carbon char have been undertaken by Monsanto's Enviro-Chem Systems, Battelle Northwest, the University of West Virginia and Union Carbide's Linde Division. Fuel oil pyrolysis has two advantages over other energy recovery processes. First, a nearby customer is not required and the output can be stored easily and transported to alternative customers.

Our Pyrolysis model plant requires an investment of $12 million. The system's economics are, however, dependent on the sale of the synthetic fuel and inorganic materials for a reasonable cost per ton range. If the fuel does not find a market, the cost per ton would increase 62 percent to $8.78 and if all the materials sold for half of their expected value, the increase would be 51 percent to $8.17. The oil produced was not considered eligible for a material output subsidy based on a $ per ton sold. (See Exhibit D-6).

EXHIBIT D - 6

PYROLYSIS

Total Investment Required: $12,334,000

Amortized: $1,500,000

Fixed: 10,100,000

Recoverable: 734,000

		Cost per Input Ton
Annual Costs		
Operating	1,734,000	
Fixed	210,000	
Capital Costs	1,343,000	
Total	$3,287,000	$10.96
Annual Revenues		
Sale of Ferrous	245,000	
Nonferrous	240,000	
Glass	168,000	
Synthetic Feul Oil	1,008,000	
Total	$1,661,000	$5.54
Net Annual Cost of Operation:	$1,626,000	$5.42

APPENDIX E

DETAILED RESULTS OF ANALYSIS OF RESOURCE RECOVERY PLANT SUBSIDIES

EXHIBIT E-1

BASELINE RESOURCE RECOVERY THROUGH MUNICIPALLY OWNED PLANTS

	PAPER (000 tons)	CANS (000 tons)	GLASS (000 tons)	ENERGY (10^{12} BTU's)
1976	96	157	107	14.5
1977	110	179	122	16.5
1978	123	202	138	18.6
1979	137	224	153	20.7
1980	150	246	168	22.7
1981	173	283	193	26.1
1982	195	320	218	29.5
1983	218	357	244	32.1
1984	240	394	269	36.3
1985	263	431	294	39.7
10 YEAR TOTAL	1705	2793	1905	257.42

EXHIBIT E-2

INCREMENTAL RESOURCE RECOVERY THROUGH MUNICIPALLY OWNED PLANTS

SUBSIDY: 30% CASH

	PAPER (000 tons)	CANS (000 tons)	GLASS (000 tons)	ENERGY (10^{12} BTU's)
1976	87	143	97	13.2
1977	99	162	111	14.9
1978	111	182	124	16.8
1979	123	201	138	18.6
1980	135	221	151	20.4
1981	153	251	171	23.1
1982	171	280	191	25.9
1983	189	310	212	28.5
1984	207	339	232	31.3
1985	225	369	252	34.6
10 YEAR TOTAL	1500	2460	1678	226.7

EXHIBIT E-3

INCREMENTAL RESOURCE RECOVERY THROUGH MUNICIPALLY OWNED PLANTS

SUBSIDY: $6/TON CASH

	PAPER (000 tons)	CANS (000 tons)	GLASS (000 tons)	ENERGY (10^{12} BTU's)
1976	35	56	39	5.2
1977	39	64	44	5.9
1978	44	71	49	6.5
1979	48	79	54	7.2
1980	53	86	59	7.9
1981	60	98	67	9.1
1982	68	111	76	10.2
1983	75	123	84	11.3
1984	83	136	93	12.5
1985	90	148	101	13.6
10 YEAR TOTAL	593	970	665	89.5

EXHIBIT E-4

INCREMENTAL RESOURCE RECOVERY THROUGH MUNICIPALLY OWNED PLANTS

SUBSIDY: 25% CONSTRUCTION GRANT

	PAPER (000 tons)	CANS (000 tons)	GLASS (000 tons)	ENERGY (10^{12} BTU's)
1976	51	84	57	7.7
1977	57	94	64	8.6
1978	63	103	70	9.5
1979	69	113	77	10.4
1980	75	123	84	11.3
1981	86	140	96	12.9
1982	96	157	107	14.5
1983	107	175	119	16.1
1984	117	192	130	17.7
1985	128	209	142	19.3
10 YEAR TOTAL	850	1390	948	128.1

EXHIBIT E-5

INCREMENTAL RESOURCE RECOVERY THROUGH MUNICIPALLY OWNED PLANTS

SUBSIDY: 50% CONSTRUCTION GRANT

	PAPER (000 tons)	CANS (000 tons)	GLASS (000 tons)	ENERGY (10^{12} BTU's)
1976	96	157	107	14.5
1977	110	179	122	16.5
1978	123	202	138	18.6
1979	137	224	153	20.7
1980	150	246	168	22.7
1981	170	278	190	25.6
1982	189	310	212	28.5
1983	209	342	233	31.5
1984	228	374	255	34.4
1985	248	406	277	37.4
10 YEAR TOTAL	1660	2718	1846	250.5

EXHIBIT E-6

INCREMENTAL RESOURCE RECOVERY THROUGH MUNICIPALLY OWNED PLANTS

SUBSIDY: 75% CONSTRUCTION GRANT

	PAPER (000 tons)	CANS (000 tons)	GLASS (000 tons)	ENERGY (10^{12} BTU's)
1976	129	212	144	19.5
1977	146	239	163	22.0
1978	162	266	181	24.5
1979	179	293	200	26.9
1980	195	320	218	29.5
1981	224	367	250	33.7
1982	252	414	282	38.1
1983	281	460	314	42.4
1984	309	507	346	46.7
1985	338	554	378	57.0
10 YEAR TOTAL	2215	3633	2475	334.2

EXHIBIT E-7

INCREMENTAL RESOURCE RECOVERY THROUGH MUNICIPALLY OWNED PLANTS

SUBSIDY: 75% CREDIT SUBSIDY

	PAPER (000 tons)	CANS (000 tons)	GLASS (000 tons)	ENERGY (10^{12} BTU's)
1976	60	98	67	9.1
1977	68	111	76	10.2
1978	75	123	84	11.3
1979	83	136	93	12.5
1980	90	148	101	13.6
1981	102	168	114	15.4
1982	114	187	128	17.2
1983	126	207	141	19.1
1984	138	226	157	20.8
1985	150	246	168	22.7
10 YEAR TOTAL	1059	1650	1125	151.9